POPULATION DYNAMICS OF THE STINKBUG *(HEMIPTERA: PENTATOMIDAE)* COMPLEX ON SOYBEAN AND COMPARISON OF TWO RELATIVE METHODS OF SAMPLING

BY

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TO

MY WIFE

AND

MY DAUGHTERS

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Abstract of Dissertation Presented to the Graduate Council
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POPULATION DYNAMICS OF THE STINKBUG *(Hemiptera: Pentatomidae)* ON SOYBEAN AND COMPARISON OF TWO RELATIVE METHODS OF SAMPLING

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and Nematology

The objectives of this three-year study conducted at the University of Florida, Agricultural Research and Education Center, Quincy, Gadsden County, Florida, include: (1) to compare sweep net and ground cloth sampling methods of measuring populations of three stinkbug species: *Nezara viridula, Acrosternum hilare,* and *Euschistus servus;* (2) to determine the distribution, species composition, and relative abundance of the pentatomids associated with soybeans in Florida; and (3) to determine the effect on stinkbug population dynamics of soybean varieties of different maturity planted on two dates.

Forrest and Bragg soybean varieties were used in 1977, Bragg and Cobb in 1978, and all three varieties in 1979.

Weekly samples of stinkbugs and other insects associated with those soybean varieties were taken by two methods: sweep net and ground cloth.

In 1977, thirteen weekly samples were made with both methods, sweep net and ground-cloth, from August through the beginning of November on each plot of Bragg and Forrest soybean variety.

In 1978, fifteen weekly samples were made with both methods on Bragg and Cobb, and in 1979, fifteen weekly samples were made with both methods on each plot of Bragg, Cobb, and Forrest soybean variety. Results are shown in Tables 1 through 16 and Figs. 1 through 168

N. viridula was the most abundant species on all planting dates in all three years, and together with results of *A. hilare*, and *E. servus* adults characteristically colonized early plantings of early maturing varieties first and in greatest numbers. As the season progressed, later plantings and later-maturing varieties became more attractive to all species and in late season these plantings supported the largest populations of both adults and nymphs of all species. As early-maturing varieties senesced, adults of all species studied moved to varieties of later maturity.

Results indicate that the trap cropping method of controlling *N. viridula* developed in Louisiana may also be used against these species in Florida.

Adults of *N. viridula* were usually the first to colonize timed plantings of Forrest, Bragg and Cobb during the three years of this study. Left uncontrolled this species produced very large nymphal and subsequent adult populations. Because of the magnitude of populations and apparent overlap, numbers of generations produced in individual plantings were impossible to determine, but it is probable that two occurred in certain plantings.

Adults of both *A. hilare* and *E. servus* were very low relative to *N. viridula.* Nymphal populations of these species likewise were low with the exception of 1979. Population trends of these two species on the times-varietal plantings appeared to be quite similar to that of *N. viridula.* Single nymphal generations were produced in 1977 and 1978, but two generations of each species occurred in some plantings in 1979.

In Florida, *A. hilare* and *E. servus* post little threat to soybean production of themselves, but as species components of the stinkbug pest complex they become significant because damage produced by members of the complex is similar and additive.

For all three species the magnitude of the regression coefficients usually increased as development proceeded. This is probably a function of the degree of aggregation of individual developmental stages.

Collections of adults and all nymphal stages of *N. viridula, A. hilare,* and *E. servus* by sweep net and ground cloth are significantly correlated. Data and regression analyses presented will allow the construction of coefficients for calibration between the methods for all development stages, on several varieties and planting dates.

INTRODUCTION

Soybean, *Glycine max* (L.) Merrill, because of its high yield of oil and protein, is a major source of food for human and animal consumption. Although the crop is being grown in many countries around the world, the United States, China, and Brazil have become centers of production. Soybean production in the United States doubled from 1960 to 1973, with the greatest rate of increase in southern latitudes (Turnipseed and Kogan, 1976). Soybeans are now the third leading crop in both acreage and value in the United States, exceeded only by corn and wheat; and of the 16 major food crops worldwide, soybean ranks sixth in acreage, exceeded only by the cereal crops, wheat, rice, corn, barley, and millet (FAO, 1977). A continuous and rapid expansion of soybean acreage has been predicted, particularly for subtropical and tropical latitudes (Amer. Soybean Assoc., 1972). In Florida, for example, soybean acreage has increased 75-fold since 1949, to 450,000 A. in 1979 (Whitty, personal communication).[*] Large increases in soybean acreage have altered the economic status of some insects; however, due to the length of the growing season and the nature of the crop, there are probably as many or more insects associated with soybean than with any other major crop produced in the U.S. Among these insect pests are the stinkbugs.

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The objectives of this three-year study include: (1) to compare sweep net and ground cloth sampling methods of measuring populations of three stinkbug species: *Nezara viridula, acrosternum hilare,* and *Euschistus servus*; (2) to determine the distribution, species composition, and relative abundance of the pentatomids associated with soybeans in Florida; and (3) to determine the effect of soybean varieties of different maturity planted on two dates on stinkbug population dynamics.

CHAPTER I

LITERATURE REVIEW

According to Herzog et al. (1981) at least 40 species of stinkbugs occur worldwide on soybeans, but damage has actually been documented for only a few of these species. According to these authors, there is at least one important stinkbug pest species on the crop in every major soybean-producing region of the world.

The following species have been reported as pests of soybean: *Nezara viridula* (L.), *Acrosternum hilare* (Say), *A. Acutum* (Dallas), *A. marginatum* (Palisot de Beauvois), *Piezodorus guidinii*) (Westwood), *P. pallescens* (Germar), *Thyanta pallidovirens accera* (Stal), *custator* (F.), *T. perditor* (F.), *Edessa meditabunda* (F.), *Euschistus servus* (Say), *E. tristigumus* (Say), *E. obscurus* (Palisot de Beauvois), *E. quadrator* (Rolston), *E. ictericus* (L.) *E. heros* (F.), *E. crenator* (F), and *E. variolarius* (Palisot de Beauvois). Based on its cosmopolitan distribution and the degree of feeding damage, the most serious species is *N. viridula*, commonly called the southern green stinkbug in the U.S.

Turnipseed and Kogan (1976) stated that the stinkbug complex and the corn earworm, *Heliothis zea* (Boddie), are the most serious soybean pod feeders in the U.S. Turnipseed (1973) listed the northern green stinkbug, *A hilare*, the southern green stinkbug, *N. viridula*, and the brown stinkbug, *E. servus*, as the three most important members of the stinkbug complex attacking soybean. According to him the green stinkbug is found in the south and northward into Missouri and some midwestern states. The southern green stinkbug is confined primarily to the southern and southeastern states, extending as far west as Texas and as far north as Arkansas, Tennessee, and Virginia (DeWitt and Godfrey, 1972). According to Blatchley (1926), the brown stinkbug, also common in the south and southeast, has been reported as far north as Massachusetts and west to New Mexico.

Deitz et al. (1976) reported the green stinkbug, *A. hilare* to be the most abundant stinkbug pest in soybeans in North Carolina, and the brown stinkbug *E. servus*, was also present in low numbers. According to Nettles et al. (1970) *N. viridula, A. hilare,* and *E. servus* are the three main species which cause soybean injury in South Carolina. Jones and Sullivan (1978, 1979) reported the ratio of *N. viridula, A. hilare,* and *Euschistus* spp. in experimental plots in South Carolina to be 52, 30, and 16%, respectively, in 1974; and 60, 19, and 20% in a 1975 test. Jones (1979) studied the distribution and abundance of pentatomids in soybeans in South Carolina, and based on sweep net and ground cloth samplings found that both the green stinkbug and the brown stinkbug occurred in all three areas of the state sampled. The southern green stinkbug was restricted primarily to the coastal plain, where it was usually the predominant species present in 1976. McPherson (1978) reported that *N. viridula, A. hilare,* and *E. servus* are the most abundant species in Louisiana.

The Main Species of Stinkbugs

A. The Southern Green Stinkbug, *Nezara viridula* (L.)

The life history of the southern green stinkbug, *N. viridula* has been studied by a number of workers in different parts of the world (Jones 1918, Drake 1920, Cumber 1949, Everett 1950, Kiritani and Hokyo 1962, Mitchell and Mau 1969, Corpuz 1969, Singh 1972, Harris and Todd 1979a, 1980a). The work of Jones (1918), Drake (1920), and Harris and Todd (1980a, b, c, d) in Louisiana, Florida, and Georgia, respectively, provide a broad data base for this species in the southern United States (Herzog et al., 1981).

In the early spring, as the days begin to warm, the bugs emerge from overwintering quarters in search of food. According to Drake (1920), mating begins almost immediately upon emergence from hibernation.

Corpuz (1969) observed 6-10 days and Mitchell and Mau (1969) 7 days for the premating period. The range of copulatory duration is 1-165h., with a mean of 37.25 ± 31 h. (Harris and Todd, 1980a). These authors reported 1-6 matings prior to oviposition (mean 1.94), and 3 days post-mating/pre-oviposition, thus, a mean pre-oviposition period of 17.5 days. Jones (1918) and Wilson and Kelsheimer (1955) reported a pr-oviposition period of about 4 weeks. There is a distinct periodicity of oviposition with 75% of the eggs being laid in the last 3 hours of daylight. The pale yellow eggs are generally laid in hexagonally-shaped clusters, with individual eggs closely packed in regular rows and firmly glued to the substrate. The average incubation time is 5 days in the summer (Harris and Todd, 1980b).

Kiritani (1963) reported that females mated repeatedly and deposited 80 to 100 eggs per mass with increasing mass size in decreasing intervals (7 to 10 days) between successive ovipositions. The average incubation period of eggs was 4 to 5 days. As incubation proceeds, the eggs become a deeper yellow, then pinkish-yellow, with a red crescent-shaped spot appearing on the operculum and, by the time of hatch, they are a rich orange color (Herzog et al., 1981). During the summer, the period from egg to adult is 35-37 days, depending on temperature (Jones, 1918; Drake, 1920; Harris and Todd, 1980a).

Harris and Todd (1980a) studied the development of *N. viridula* in the laboratory. In their study they used 75 egg masses laid by 20 females, and monitored development in the laboratory under controlled conditions of 25-28°C, 55-65% RH, and a 14 h. photophase. The mean nymphal development period (days) was 36.7, divided by stages as follows: egg,4.8; 1st instar, 3.8; 2nd instar, 5.2; 3rd instar, 4.5; 4th instar, 6.4; 5th instar, 11.9. They compared these observations with seven previous studies conducted in five countries, and they discussed inconsistencies among those studies concerning the possible effects of temperature, photoperiod, latitude, and rearing method.

According to Jones (1918) nymphal development was first instar, 3 days; second instar, 4 days; third instar, 5 days; fourth instar, 6 days; fifth instar, 7 days. (Kariya (1961) reported 20° to 30°C was the optimal temperature range for development. In the first instar, nymphs cluster on or near the egg mass and have not been observed to feed. Drake (1920) stated that the nymphs begin to disperse and feed, just before or subsequent to molting.

The tendency to aggregate carries through the third stage and is reported to have an effect on the rate of development and mortality (Kiritani, 1964a; Kiritani et al., 1965; Kiritani and Kimura, 1965, 1967). Rizzo (1968) studied this stinkbug in Argentina and according to him 7 to 20 days after mating the female lays eggs in variable numbers of from 55 to 105, rarely less than 55 eggs. The nymphal stage has five instars and they have the following scheme: first, 3-9 days; second, 4-12 days; third, 5-10 days; fourth, 6-13 days; and fifth, 7-16 days, depending upon the temperature. Kiritani et al. (1966) demonstrated that the mortality rate increased at adult emergence, leveled off at a constant rate until 60% mortality occurred, then suddenly increased thereafter. Jones (1918) reported an average male longevity of 44 days and female longevity of 51 days. Jones (1918) and Drake (1920) observed four generations per year in Louisiana and Florida, respectively, and according to Drake (1920) a fifth generation probably occurred in the southern portion of Florida. The nymphs, like the adults, are usually found upon those portions of the plant on which they prefer to feed, namely the tender growing shoot and especially the developing fruit (Herzog et al., 1981).

B. The Green Stinkbug, *Acrosternum hilare*

The green stinkbug, *Acrosternum hilare*, for a long time called the soldier bug, is one of those insects that may occasionally cause serious damage to widely different plants. In Utah, this species mated in mid-June, and oviposition extended from June to September, peaking during July (Sorenson and Anthon, 1936). Females laid from 6 to 114 eggs averaging 41.5 (N=5). The incubation period ranged from 5-14 days. with an average of 8.1 days. The mean period of nymphal development per instar was: first, 5.06 days; second, 11.5 days; third 12.5 days; fourth, 16.5 days; and fifth, 20.7 days. Whitmarsh (1917) observed that green stinkbug females may deposit three clusters of eggs, with the first cluster always the largest, usually between 40 and 50 eggs. The normal period of incubation seems quite constant, as a rule, being 7-8 days. Underhill (1934) stated that in Virginia, the period of incubation of egg masses was 8.39 days; a female deposited 75-80 eggs. Nymphal development required (averages): first, 5.1 days; second, 5.9 days; third, 6.3 days; fourth, 7.2 days; and fifth 4.1 days. The average number of days from egg to adult was 38.5 days. Sailer (1953) reared *A. hilare* in confinement and speculated that more than one generation would occur in a season. The average time required for development was 55.2 days, with a minimum of 49 and a maximum of 81.

C. The Brown Stinkbug, *Euschistus servus*

Woodside (1946) observed that the number of eggs per cluster varied from 1-28, the average being 16.3. The length of the incubation period was 8.7 days, and first instar, 5.5 days; second instar, 8.4 days; third instar, 9.0 days; fourth instar, 12.3 days; and fifth instar, 17.8 days. The total nymphal period was 53.2 days. Rolston and Kendrick (1961) working with this stinkbug in Arkansas, found an average of 21.1 eggs per cluster. The average incubation period was 5.4 days, ranging from 3-14, and the durations of nymphal stadia were: first, 3.7 days; 1-2, 8.8 days; 1-3, 13.7 days; 1-4, 20.6 days; 1-5, 33.3 days. Nymphal development time ranged from 23-63 days. The combined egg and nymphal stages were completed in an average of 38.1 days.

Nature of Damage

Several workers have described the effects of damage to soybeans by stinkbugs. According to Jones (1976), nymphal and adult stinkbugs damage soybeans by piercing the pod wall into the developing seed. Salivary enzymes are injected into the seed and the liquified tissues are then withdrawn through the stylets. They attack all parts of a plant including stems, foliage (particularly leaf veins), flowers, and fruit, but prefer the tender young growth and fruiting structures. The feeding punctures form minute, hard brownish or blackish spots on the seed. The loss of plant juices, the injection of powerful digestive enzymes, and the profusion of entry sites for pathogenic and decay organisms all contribute to crop injury. The extent of stinkbug damage to soybeans depends upon the stage of seed development at which feeding occurs. Feeding by stinkbugs during the early stage of seed formation can result in shriveled, deformed, and undersized seeds; whereas, feeding during later stages of endosperm development results in a weakened, deformed area with puncture marks where the stylets pierced the seedcoat. The flesh of the cotyledons is often shrunken and deformed beneath the seedcoat, with a whitish chalky area where the cell's contents have been removed. Frequently, a dark discoloration may be present around the punctured area and the inner membrane of the seedcoat may be fused to the cotyledons rather than being free as is normal (Kilpatrick and Hartwig, 1955; Blickenstaff and Huggans, 1962; Daugherty et al., 1964; Miner, 1966; Turner, 1967; and Herzog et al., 1981).

Clower and Hankins (1960) and Miner (1966) indicated that high infestations of *N. viridula* could occur in maturing soybeans without any appreciable degree of yield reduction; however, stinkbugs could conceivably reduce yield through early infestations or in late maturing soybean varieties.

Soybean seeds damaged by southern green stinkbugs have a slightly higher protein content and a slightly lower oil content than non-damaged beans (Miner, 1961, 1966). As the severity of stinkbug damage increases, linoleic, palmitic, stearic, and oleic acids increase, while linolec decreases (Todd et al., 1973). Seed damage can also reduce germination, emergence, and seedling vigor (Jensen and Newsom, 1972; Todd and Turnipseed, 1974; Thomas et al., 1974).

Stinkbug damage not only affects soybeans directly through reduction in yield and quality, but also by providing entry sites for disease organisms such as the yeast spot disease, *Nematospora coryli* Peglion. In Florida stinkbugs in conjunction with wet weather may spread anthracnose, *Glomerella glycines* L. and W., and cercospora spot, *Cercospora* sp. (Genung et al., 1964). Ragsdale (1977) reported that the southern green stinkbug transmits the causal organisms of several bacterial diseases of soybean.

Economic threshold studies have been conducted with the southern green stinkbug by Miner (1966), Duncan and Walker (1968), Todd and Turnipseed (1974), and Thomas et al. (1974), and with the green stinkbug by Blickenstaff and Huggans (1962), Daugherty et al. (1964), and Miner (1966). Their results show that one adult or large nymph per 3 row-ft. during seed enlargement and one bug per row-ft. after seeds are full size causes sufficient damage to justify treatment. McPherson et al. (1979), studying the stinkbug complex in Louisiana, reported similar results; however, their work revealed that late instar nymphs and adults of *E. servus* produced damage comparable to that of *N. viridula* and *A. hilare* when population densities were maintained at high levels. Miner (1966) compared the damage to soybean by the brown, green, and southern green stinkbugs in field cages. According to him the type and severity of damage by the green stinkbug was identical to damage by the southern green stinkbug. Field studies by Duncan and Walker (1968) revealed that 61.1, 45.6, and 33.1% damaged seeds were produced by densities of the southern green stinkbug of 2.5, 1.1, and 0.7/row-ft. when maintained over a 7-week period.

Sampling

The methods most commonly used to sample above ground populations of arthropods are: (a) direct observations, (b) ground cloth, (c) sweep net, and (d) vacuum or suction net (usually a D-Vac). The direct observations and the ground cloth may approach absolute or direct population estimates for some species, while the other two are relative sampling methods.

Stinkbug sampling in soybeans is difficult due mainly to the clumped distribution early in the life cycle and a more nearly random distribution in later stages at high population densities. Since stinkbug damage is not readily visible in the growing crop, actual counts must be made necessitating greater effort in order to determine stinkbug population levels adequately.

Absolute quantitative measurements of stinkbug populations are best made utilizing the fumigation cage method (Marston et al., 1976). The ground cloth method of sampling so nearly approximates the absolute measurement of stinkbug populations that it may be considered as absolute and it is easy and quick (Todd and Herzog, 1980). Marston et al. (1976) compared three relative sampling methods with an "absolute" fumigation cage method. The fumigation cage and ground cloth methods collected significantly larger numbers of stinkbugs than did the vacuum net and sweep net methods.

Duncan (1968) comparing sweep net and ground cloth methods for sampling of *N. viridula*, concluded that fourth and fifth nymphal instars and adults were sampled with equal efficiency by both techniques, while second and third nymphal instars were not sampled adequately with either method.

Rudd and Jensen (1977) compared sweep net and ground cloth sampling methods for *N. viridula*. They showed by regression analysis that numbers of stinkbugs captured by the two methods were highly correlated, ranging from r = 0.835 for *N. viridula* females to r = 0.982 for fourth instar *N. viridula*, with r = 0.998 for third, fourth and fifth instars and adults combined. They concluded that a larger number of samples are required to measure a population mean with the ground cloth than with the sweep net (Herzog et al., 1981).

The time required for acquisition of samples was reported by Rudd and Jensen (1977) as 21.2 and 48.3 seconds/sample for the sweep net (25 sweeps) and ground cloth (6 row-ft.) methods, respectively. Their data indicate that the sweep net was superior to the ground cloth for most sampling objectives based on time required per observation. Since this research was with *N. viridula*, it cannot be directly related to other phytophagous pentatomids. Behavior probably differs among species to such an extent that factors for calibrating between sampling methods, calculated from regression analyses, would be significantly different for other species. However, for pest management purposes in the southeastern United States where *N. viridula* is the predominant species, calibrations for this species may be used without incurring significant error (Herzog et al., 1981).

For over a century the sweep net has been the most widely used tool for sampling arthropods on small grain, forage, and many row crops. One reason for this popularity, despite difficulties in standardizing the method for accurate population studies, is that no other method can capture as many insects from vegetation per man hour and with as little damage to the crop and cost for equipment (Ruesink and Kogan, 1975).

Population Dynamics

Understanding the population dynamics of pest species is essential for development of sound pest management systems. Seasonal abundance of soybean insect pests and predators have been reported by Raney and Yeargan (1977), Wuensche (1976), Deitz et al. (1976), Kogan et al. (1974), Carner et al. (1974), Shepard et al. (1974), Burleigh (1972), Pedigo et al. (1972), and Herzog (1968). Little information is available on the abundance and population dynamics of stinkbug pests of soybeans, however.

N. viridula has a complex population profile (Harris and Todd, 1980a). It is polyandrous, polygamous, multivoltine, and long lived as an adult, thus producing an overlap of generations (Kiritani, 1963; Harris and Todd, 1980b).

Weather, population density, food, and natural enemies have all been cited as factors which influence the population dynamics of *N. viridula*. Jones (1918) observed heavy mortality to adults in the winter months in Louisiana during sudden drops in temperature. According to Kiritani and Hokyo (1962), adverse weather conditions are major mortality factors for eggs and early nymphal instars.

In a five-year study, Kiritani (1964b) concluded that abundance of *N. viridula* was partly determined by the combination and relative abundance of host plants, and partly by climatic factors. He found winter to be the critical period for survival for this species with habitat heterogeneity and hibernacula the only means of insuring winter survival.

Herzog et al. (1981) postulated that all developmental stages are present on soybeans in Louisiana, Georgia, and Florida until harvest and may be collected from unharvested plants as late as mid-December. Bratley (1936, 1941) reported reduced populations of *N. viridula* in the spring in Florida following severe winters.

Although *N. viridula* often invades soybean fields in large numbers early in the season, it barely maintains its population level until pod formation when the population increases drastically (Newsom et al.,1975, Wuensche, 1976).

Kiritani (1965) found that local overpopulation tends to increase mortality among immature *N. viridula* and decreases longevity, body weight, and fecundity of adults. He considered this a key factor in keeping populations in check.

Pitts (1977) observed that despite a reproductive diapause in *N. viridula*, overwinter survival is enhanced by the presence of succulent food. Adults often become active and feed during mild periods in the winter. The availability of cold-hardly plants, such as mustard, greatly increased survival of *N. viridula* by providing an excellent hibernaculum and a constant source of food.

The brown stinkbug, *Euschistus servus*, is an occasional pest of several vegetable crops in Arkansas (Rolston and Kendrick, 1961). Two generations occur in the northwestern section of the state, but few of the second generation nymphs become adults. The adults overwinter feed on common mullein in the spring before other hosts become available. They collected this species in small numbers on several field crops, none of which appeared to be particularly favored as a host.

As the weather begins to warm in spring, adults move into clover, early vegetables, corn, and tobacco where they feed or oviposit (Herzog et al., 1981). The resultant nymphs and adults constitute the first generation. Tomatoes, leguminous and cruciferous vegetables, and okra become attractive in April, May, and June, and these provide the major food sources and oviposition sites during early and mid-summer. Although a few individuals can be found in soybeans throughout the growing season, they provide a suitable food only after flowering and podset. According to the authors, this usually occurs in late July and August. By then, third generation adults are present and immigrate into soybeans which provide the major source of food in late summer and early fall (late July through November). Soybeans are not the only source of food for these species in Central and North Florida during this period as the very abundant weeds *Desmodium* sp. and *Crotalaria* sp. are excellent hosts (Sailer, personal communication).*

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CHAPTER II

MATERIALS AND METHODS

General Experimental Procedures

Studies were conducted at the University of Florida, Agricultural Research and Education Center, Quincy, Gadsden County, Florida, using Forrest and Bragg soybean varieties in 1977, Bragg and Cobb in 1978, and Bragg, Cobb and Forrest in 1979.

General Experiments in 1977, 1978, and 1979

The soybeans were grown with the standard cultural practices described by Hinson (1967) and Whitty et al. (1971). The crop was planted at approximately 67 Kg/ha with a row spacing of 0.91 m. The herbicides trifluralin 4EC and metribuzin 70WP were incorporated into the soil prior to planting at rates of 0.56 and 0.29 Kg/ha, respectively. At cracking time, alachlor 4EC and dinitroamine 2EC were applied at rates of 2.25 and 0.37 Kg/ai/he, respectively.

Forrest (Maturity Group V) and Bragg (Maturity Group VII) soybean varieties were each planted on June 7, 1977, and June 22, 1977. Early-planted Forrest bloomed by July 17, and pod-fill began by August 10. Early-planted Bragg bloomed by July 24, and pod-fill began by August 20. Late-planted Forrest bloomed by July 31 and pod-fill began by August 22. Late-planted Bragg bloomed by August 4 and pod-fill began by August 29.

Bragg and Cobb (Maturity Group VIII) soybean varieties were planted on June 13 and June 30, 1978. Early-planted Bragg bloomed by July 29 and pod-fill began by August 22. Early-planted Cobb bloomed by August 5 and pod-fill began by September 4. Late-planted Bragg bloomed by August 10 and pod-fill began by September 3. Late-planted Bragg bloomed by August 10 and pod-fill began by September 3. Late-planted Cobb bloomed by August 18 and pod-fill began by September 10.

All three varieties were planted again on June 12, 13, and 27, 1979. Early-planted Forrest bloomed by July 25 and pod-fill began by August 22; meanwhile, Bragg bloomed by August 2 and pod-fill began by August 25. Cobb bloomed by August 11 and pod-fill began by September 6. Late-planted Forrest bloomed by August 7 and pod-fill began by August 27; meanwhile, Bragg bloomed by August 10 and pod-fill began by September 1. Cobb bloomed by August 18 and pod-fill began by September 12.

Each plot consisted of 60 rows 24.38 m long; plots were arranged in a "split-plot" design. In each year the experiment was replicated two times.

Weekly samples of stinkbugs and other insects associated with those soybean varieties were taken by two methods: sweep net and ground cloth. In the ground cloth method the cloth was placed between two rows of soybean, so that it was located beneath undisturbed foliage (Boyer and Dumas, 1963, 1969). Approximately 0.61 row/m of soybeans on each side were then vigorously shaken over the cloth. The stinkbugs and other insects that fell onto the cloth were collected and transferred to a plastic bag and were counted and recorded later. All second-fifth instars as well as adult pentatomids were identified and recorded. Sixteen samples per plot were taken along a diagonal, in order to sample the whole plot. Two rows were skipped between sampled rows.

A modification of the sweep net method described by DeLong (1932) was used. This was the one-row variation as described by Kogan and Pitre, Jr. (1980). Sweeps were taken while walking beside the row, holding the handle of a 38 cm diameter sweep net directly in front of the observer, with the opening of the net always facing the row of plants to be sampled. Sixteen samples consisting of 50 consecutive sweeps ca. 0.61 m apart from alternating sides of the row while walking beside it, were taken per plot. After 50 sweeps in a single row, contents of the net were transferred to a plastic bag, and later counted and recorded. Two rows were skipped between sampled rows.

In 1977, thirteen weekly samples were made with both methods, sweep net and ground cloth, from August through the beginning of November on each plot of Bragg and Forrest soybean varieties.

In 1978, fifteen weekly samples were made with both methods on Bragg and Cobb, and in 1979, fifteen weekly samples were made with both methods on each plot of Bragg, Cobb, and Forrest soybean varieties.

Statistical Analyses

Two statistical analyses were performed:

A. The model used for the 1977, 1978, and 1979 experiments was:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + \varepsilon_{aij} + \gamma_k + \alpha\gamma_{ik} + \beta_{jk} + \alpha\beta_{ijk} + \varepsilon_{bijk}$$

where

μ = overall population mean

α_i = i^{th} planting date effect

β_j = j^{th} variety effect

$\alpha\beta_{ij}$ = ij^{th} planting date x variety interaction effect

ε_{ij} = ij^{th} main plot error

γ_k = k^{th} week effect

$\alpha\gamma_{ik}$ = ik^{th} planting date x week interaction effect

$\beta\gamma_{jk}$ = jk^{th} variety x week interaction effect

$\alpha\beta\gamma_{ijk}$ = ijk^{th} planting date x variety x week interaction effect

ε_{ijk} = ijk^{th} subplot error.

The design was a split plot arrangement of treatments in a completely randomized design for each of three years. In 1977 and 1978, a 2 x 2 factorial was used on the main plot; for 1979, a 2 x 3 factorial was used on the main plot. On the split plot, 13 sampling dates were used for 1977 and 15 each for 1978 and 1979. For each year, the analysis was run for each combination of two collection methods, 3 species and 6 stages of insect development (including instars 2 to 5 and the adults).

B. The model used was:

$$Y_i = \beta_o + \beta_1 X_{i1} + \varepsilon_i$$

where

Y_i = i^{th} stinkbug count by sweep net

X_i = i^{th} stinkbug count by ground cloth

ε_i = i^{th} random error

β_0 = number of stinkbugs collectible by sweep net when no stinkbugs are collected by ground cloth

β_1 = changes in number of stinkbugs collected by sweep net per unit increase in number collected by ground cloth.

For each of 3 years, the collection by ground cloth was regressed on the collection by sweep net. This was done for each combination of

(i) 2 planting dates, 2 (or 3) varieties, 3 species and 6 stages;

(ii) 3 species and 5 stages (instar 2 omitted); and

(iii) 3 species (instar 2 omitted); over all other factors.

ANOVA and summary of results tables were made for each species, stages, and methods studied.

Data presented in Figs. 1 - 84b represent mean numbers of each stage collected per plot, representing 16 samples per plot. Ground cloth samples consisted of 1.22 row/m, and sweep net samples 50 sweeps. Therefore, data are figured on a basis of 19.51 row/m or 800 sweeps per plot.

CHAPTER III

EFFECTS OF SOYBEAN VARIETY AND PLANTING DATE ON ABUNDANCE OF DEVELOPMENTAL STAGES OF *N. viridula, A. hilare,* AND *E. servus*

Results

Stinkbug populations were sampled weekly with ground cloth on two or three soybean varieties planted on two dates during 1977, 1978, and 1979. From initial analyses, significant first- and second-order interactions with week were detected. Since these interactions were expected, and in order to resolve the effect of the other factors above the week effect, it was decided to partition the experimental period. Due to the size of the data, the number of partitions should be fewer than the number of sampling dates. The intention of partition was based on overall relative population growth (first period), a second period of relative stability, and a third period of decline were determined. Sampling periods did not always encompass the same crop growth stages among varieties and planting dates.

N. viridula Adults

Populations of *N. viridula* adults sampled from early and late planting dates of Forrest and Bragg varieties in 1977, Bragg and Cobb in 1978, and Forrest, Bragg and Cobb in 1979 are shown in Figs. 1 through 14, respectively. Results of statistical analyses are shown in Table 1.

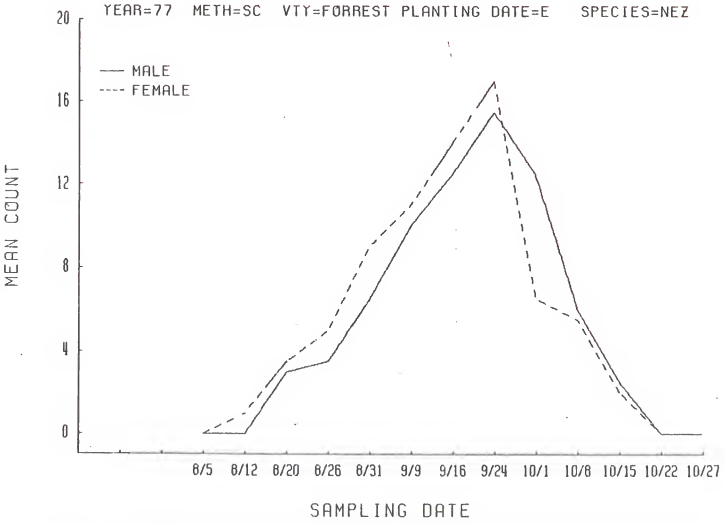

Fig. 1. Populations of *N. viridula* adults collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1977.

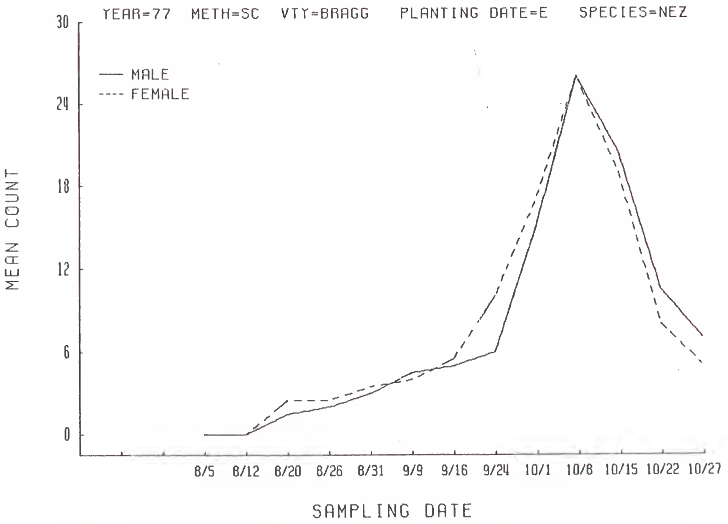

Fig. 2. Populations of *N. viridula* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1977.

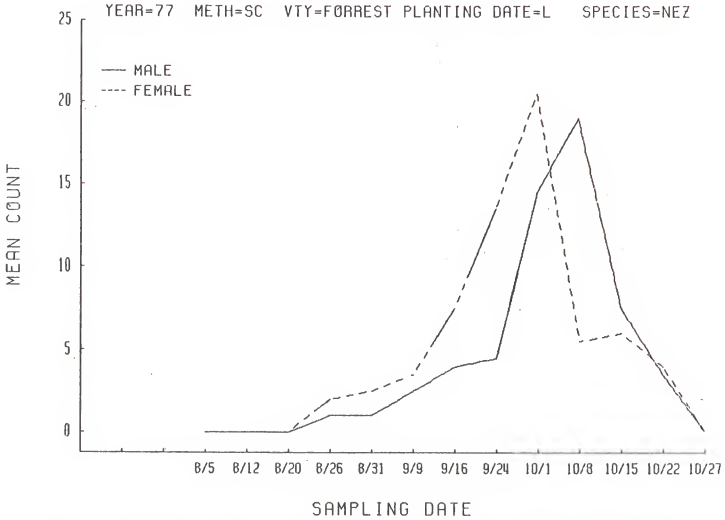

Fig. 3. Populations of *N. viridula* adults collected by ground cloth on late - planted Forrest variety. Quincy, Florida, 1977.

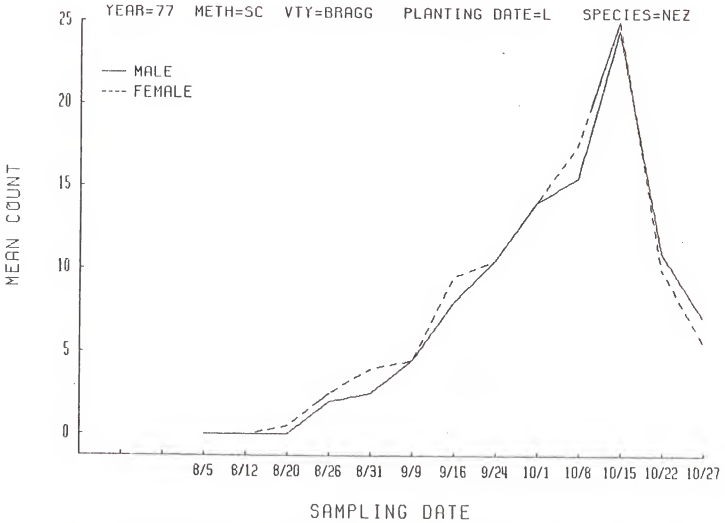

Fig. 4. Populations of *N. viridula* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1977

In 1977, there was a significant difference in adult populations in the first (female and male $P<0.05$) and third sampling periods (female $P<0.01$, male $P<0.05$) on Forrest and Bragg varieties. No significant differences ($P<0.05$) occurred in the second sampling period. Populations of both males and females differed significantly ($P<0.1$) between planting dates in the first sampling period, but no significant differences were obtained in the second or third sampling periods. Variety times planting date interactions were significant ($P<0.05$) for both sexes in the first and second sampling periods, but were nonsignificant ($P>0.05$) in the third.

In 1978, no significant difference ($P>0.05$) *N. viridula* adult abundance was detected between Bragg and Cobb varieties. Both males and females differed significantly ($P<0.01$) between early and late planting dates during the first sampling period, but no such differences ($P>0.05$) were detected in the second or third sampling period. No significant ($P>0.05$) variety times planting date interactions occurred.

In 1979, both sexes differed significantly among varieties in the second ($P<0.05$) and third ($P<0.01$) sampling periods, but no significant difference ($P>0.05$) was detected among varieties in the first sampling period. Adult populations differed significantly among planting dates in the first ($P<0.05$), second ($P<0.01$) and third sampling periods (female $P<0.01$, male $P<0.05$). No significant ($P>0.05$) variety times planting date interaction occurred.

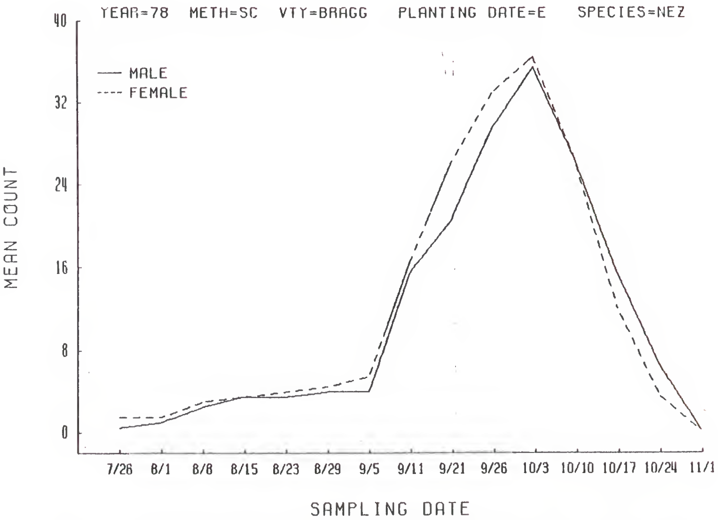

Fig. 5. Populations of *N. viridula* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1978.

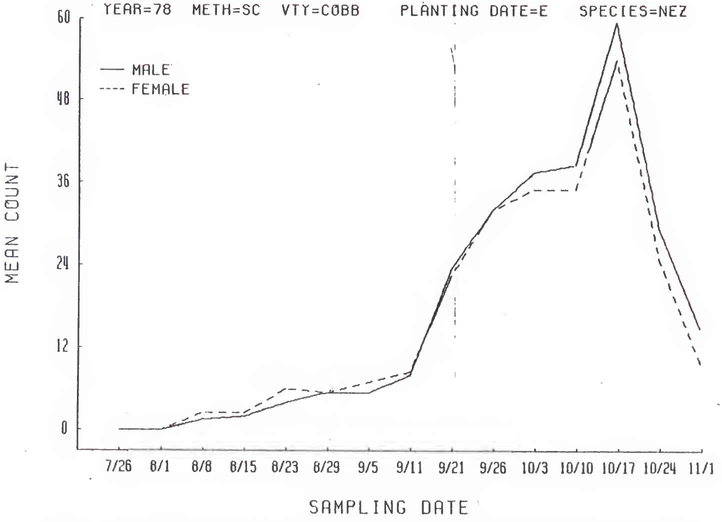

Fig. 6. Populations of *N. viridula* adults collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1978.

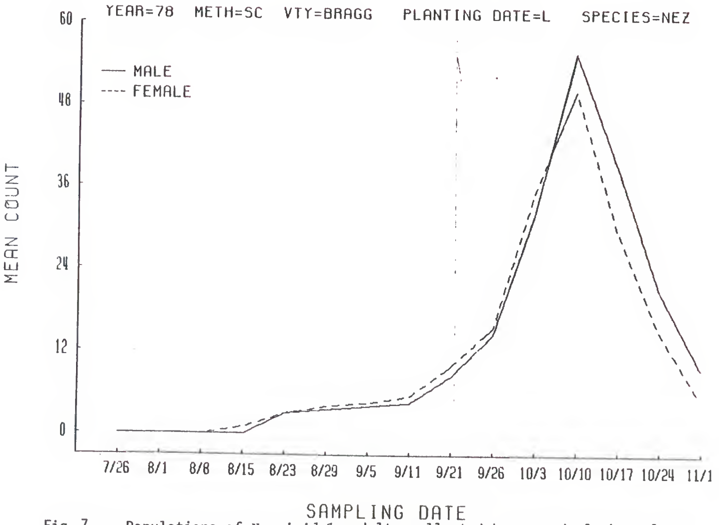

Fig. 7. Populations of *N. viridula* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1978.

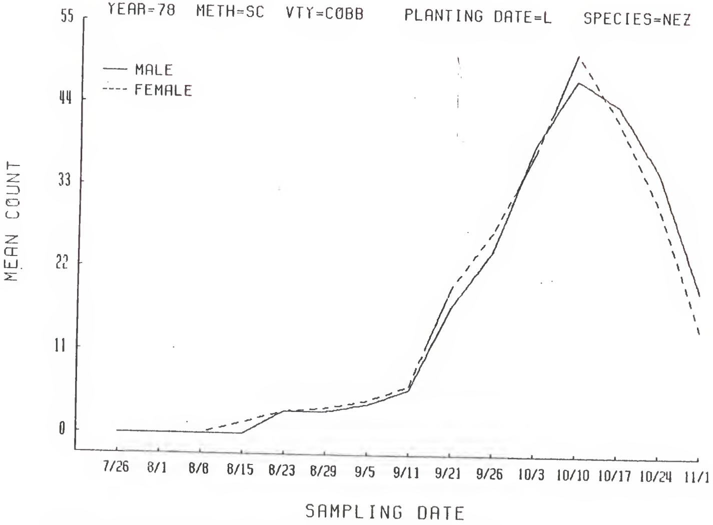

Fig. 8. Populations of *N. viridula* adults collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1978.

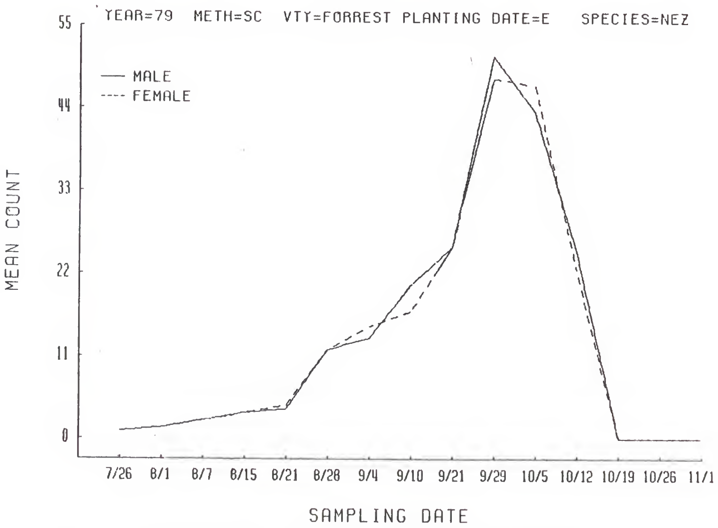

Fig. 9. Populations of *N. viridula* adults collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1979.

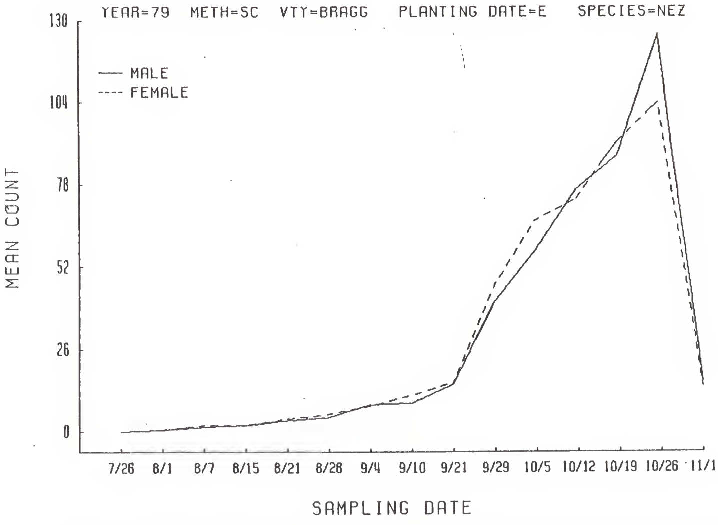

Fig. 10. Populations of *N. viridula* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1979.

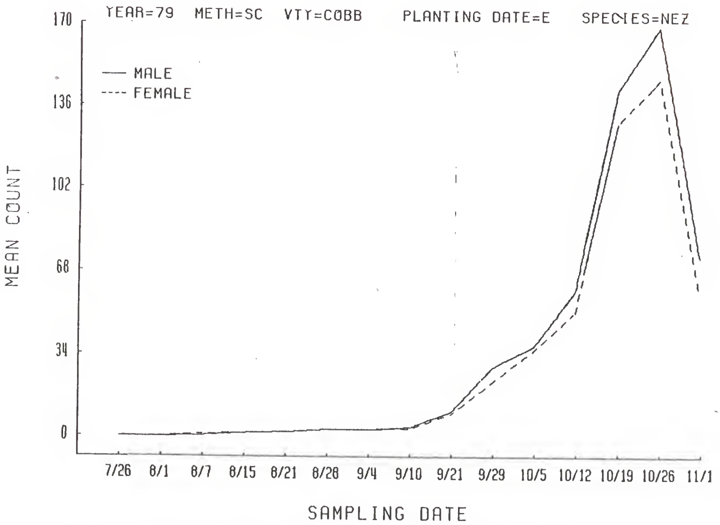

Fig. 11. Populations of *N. viridula* adults collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1979.

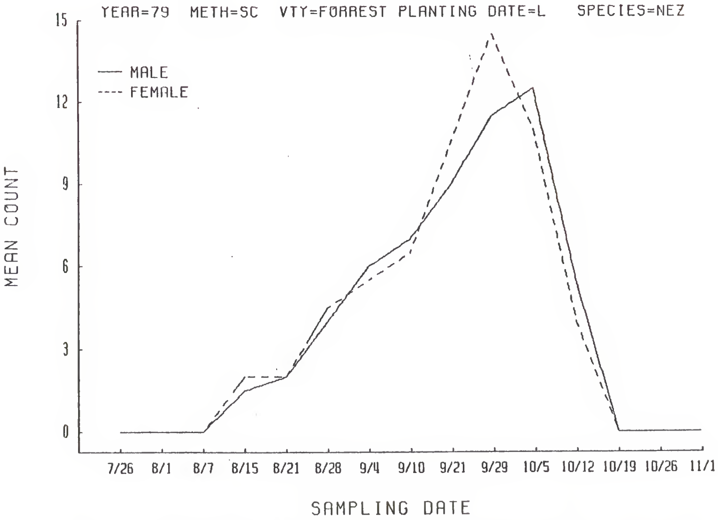

Fig. 12. Populations of *N. viridula* adults collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1979.

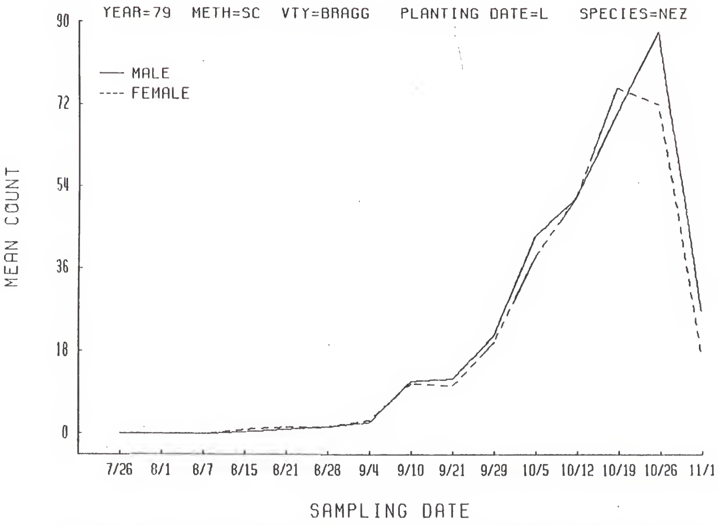

Fig. 13. Populations of *N. viridula* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1979.

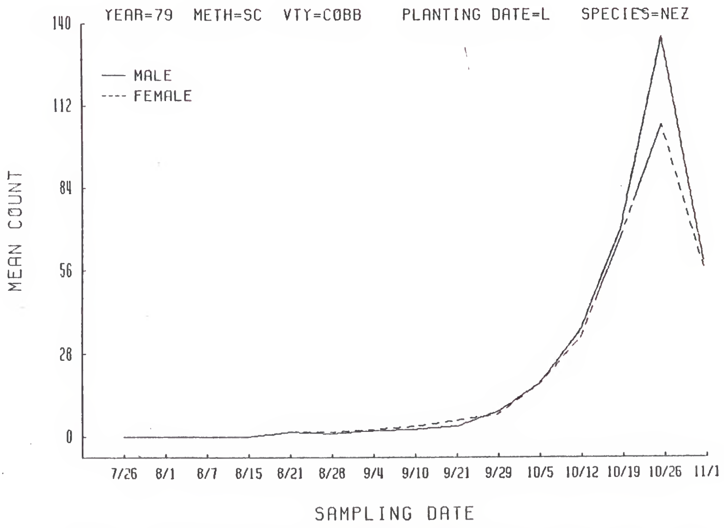

Fig. 14. Populations of *N. viridula* adults collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1979.

Table 1. Results of analyses of variance for *N. viridula* concerning variety and planting date effects and variety x planting date interaction.

Year	Period	First		Second			Third		
1977	Date	8/5 to 8/20		8/26 to 9/24			10/1 to 10/27		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	Pd.xVty
Female	**	*	*	NS	NS	*	NS	**	NS
Male	**	*	*	NS	NS	*	NS	*	NS
Fifth	*	NS	NS	NS	NS	NS	NS	*	NS
Fourth	*	NS	NS	NS	NS	NS	NS	**	NS
Third	*	NS	NS	NS	NS	NS	NS	NS	NS
Second	**	NS	NS	NS	NS	NS	NS	NS	NS
1978	Date	7/26 to 8/23		8/29 to 9/26			10/3 to 11/1		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	Pd.xVty
Female	**	NS	NS	NS	NS	NS	NS	NS	NS
Male	**	NS	NS	NS	NS	NS	NS	NS	NS
Fifth	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fourth	NS	NS	NS	NS	NS	NS	NS	NS	NS
Third	NS	NS	NS	NS	NS	NS	NS	NS	NS
Second	NS	NS	NS	NS	NS	NS	NS	NS	NS
1979	Date	7/26 to 8/21		8/28 to 9/29			10/5 to 11/1		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	PdxVty
Female	*	NS	NS	**	*	NS	**	**	NS
Male	*	NS	NS	**	*	NS	*	**	NS
Fifth	*	NS	NS	**	NS	NS	NS	**	NS
Fourth	*	NS	NS	*	NS	NS	NS	**	NS
Third	**	NS	NS	NS	NS	NS	NS	NS	NS
Second	*	NS	NS	NS	NS	NS	NS	NS	NS

NS = Nonsignificant ($P > 0.05$)

* = Significant ($P < 0.05$)

** = Highly significant ($P < 0.01$)

N. viridula Nymphs

Populations of *N. viridula* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 15 through 28. Results of statistical analyses are shown in Table 1.

In 1977, no significant differences ($P>0.05$) were detected in nymphal populations between Forrest and Bragg varieties, except in the third sampling period, when numbers of fourth and fifth instars differed significantly ($P<0.01$ and $P<0.05$, respectively). No significant differences ($P>0.05$) were detected in nymphal populations between planting dates, except in the first sampling period, when numbers of second and third through fifth instars differed significantly (P 0.01 and $P<0.05$, respectively). No significant ($P>0.05$) variety x planting date interactions occurred.

In 1978, no significant differences ($P>0.05$) were detected in nymphal populations between Bragg and Cobb varieties or between planting dates. No significant ($P>0.05$) variety x planting date interactions were detected.

In 1979, no significant differences ($P>0.05$) were detected in nymphal populations between Forrest, Bragg and Cobb varieties, except in the third sampling period, when numbers of fourth and fifth instars differed significantly ($P<0.01$). In the first sampling period numbers of all nymphal stages sampled (second through fifth) differed significantly ($P<0.05$) for second, fourth and fifth, $P<0.01$ for third) between planting dates. In the second sampling period numbers of fourth and fifth instars only differed significantly ($P<0.05$ and $P<0.01$, respectively) between planting dates. In the third sampling period

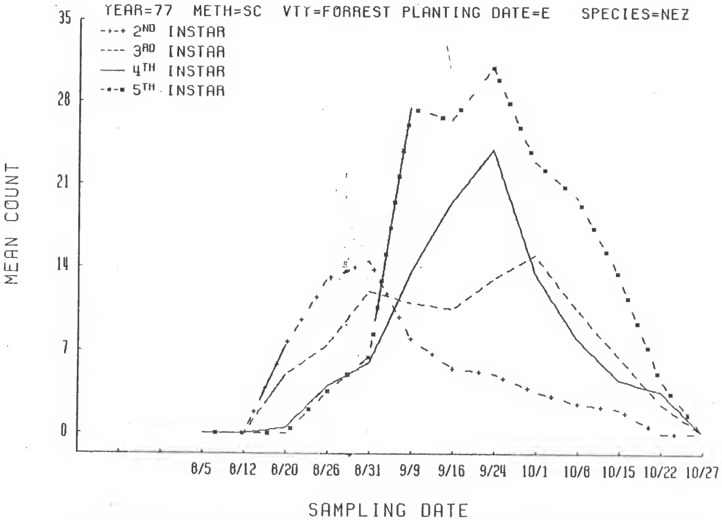

Fig. 15. Populations of *N. viridula* nymphs collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1977.

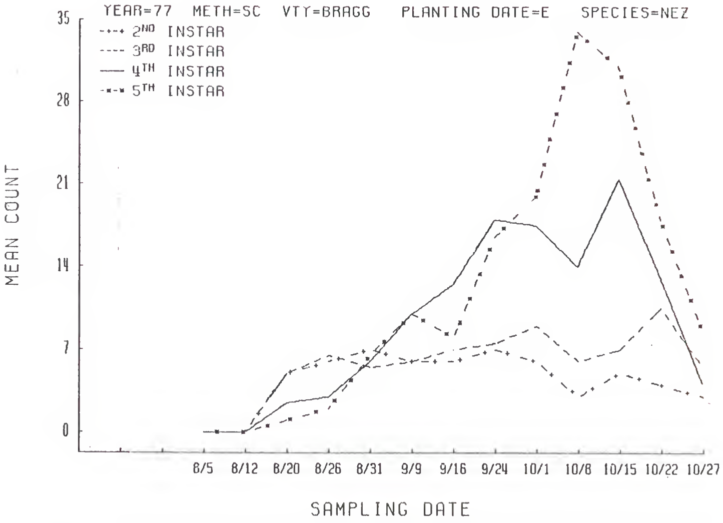

Fig. 16. Populations of *N. viridula* nymphs collected by ground cloth on early planted Bragg variety. Quincy, Florida, 1977.

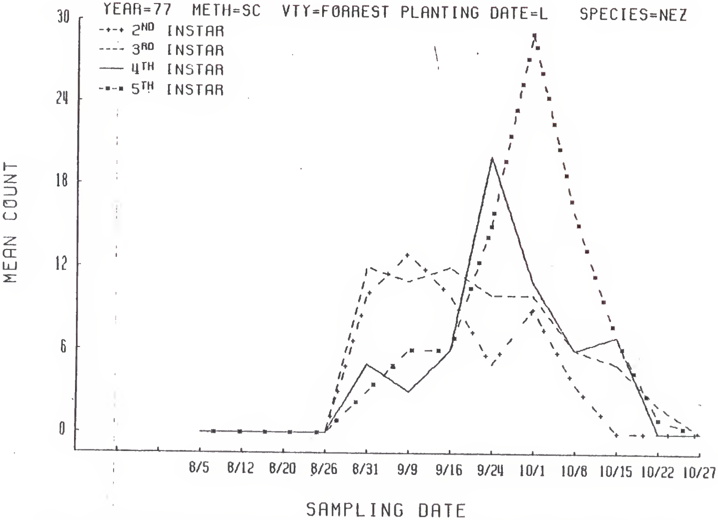

Fig. 17. Populations of *N. viridula* nymphs collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1977.

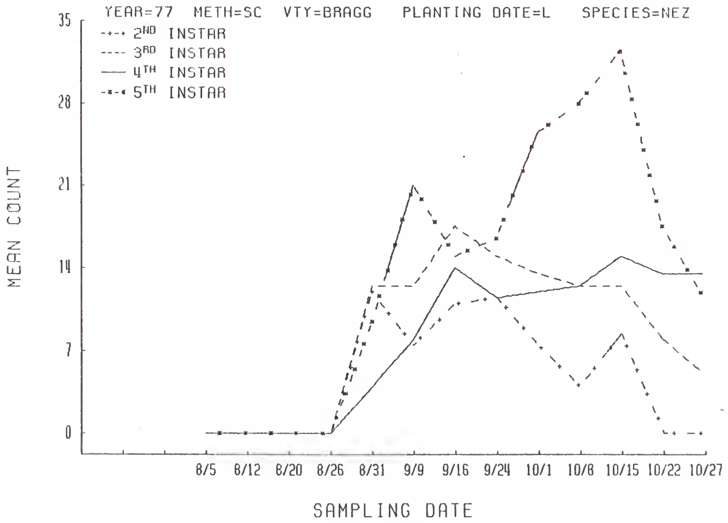

Fig. 18. Populations of *N. viridula* nymphs collected by ground cloth on late-planted Bragg variety. Quincy, Florida 1977.

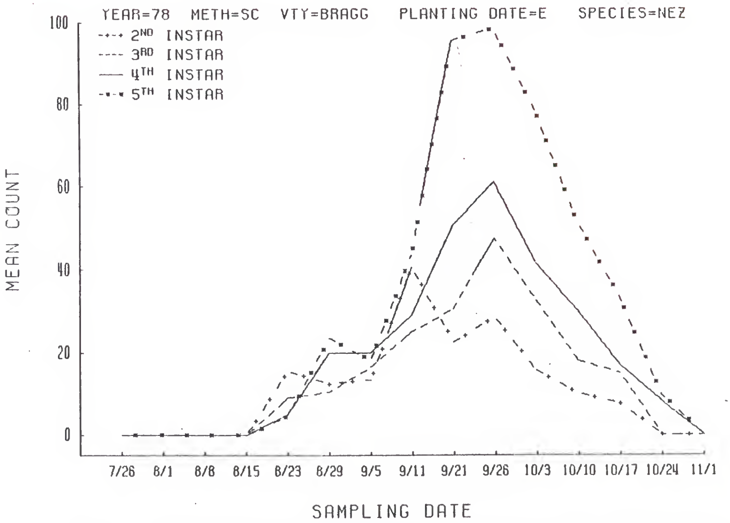

Fig. 19. Populations of *N. viridula* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1978.

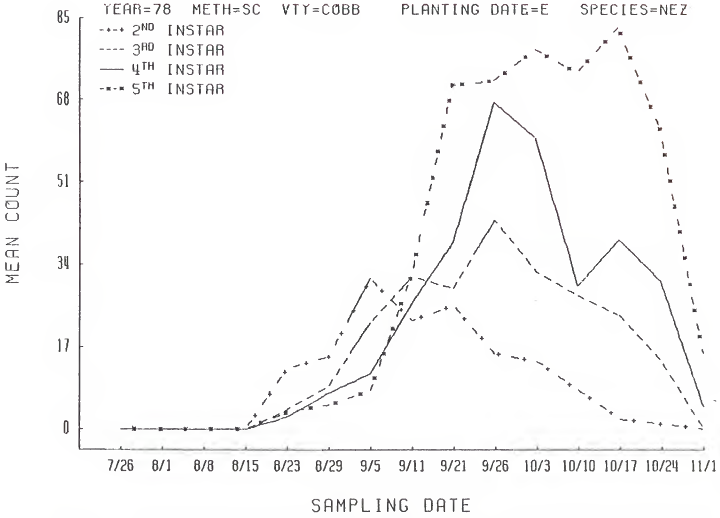

Fig. 20. Populations of *N. viridula* nymphs collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1978.

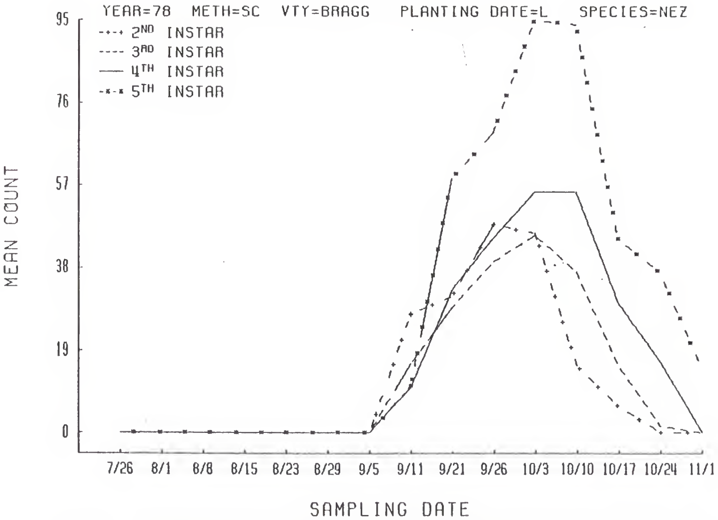

Fig. 21.. Populations of *N. viridula* nymphs collected by ground cloth on late-planted Bragg variety.. Quincy, Florida, 1978.

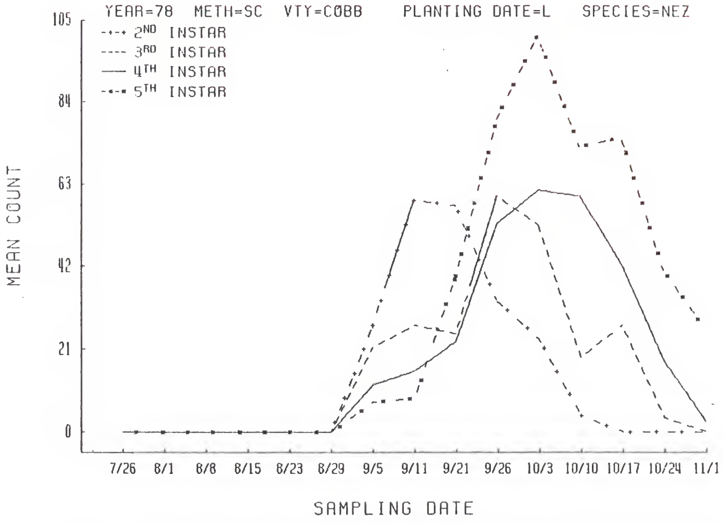

Fig. 22. Populations of *N. viridula* nymphs collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1978.

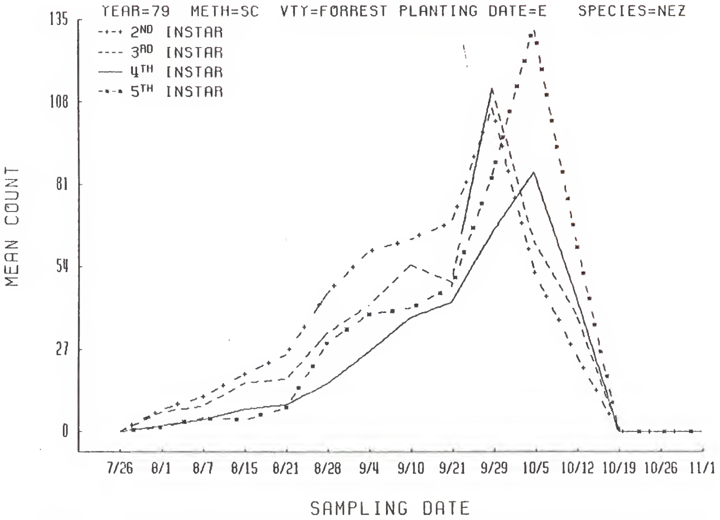

Fig. 23, Populations of *N. viridula* nymphs collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1979.

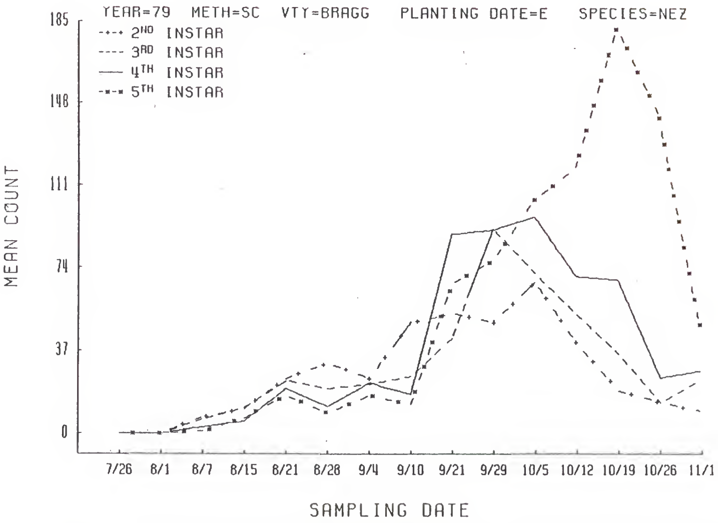

Fig. 24. Populations of *N. viridula* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1979.

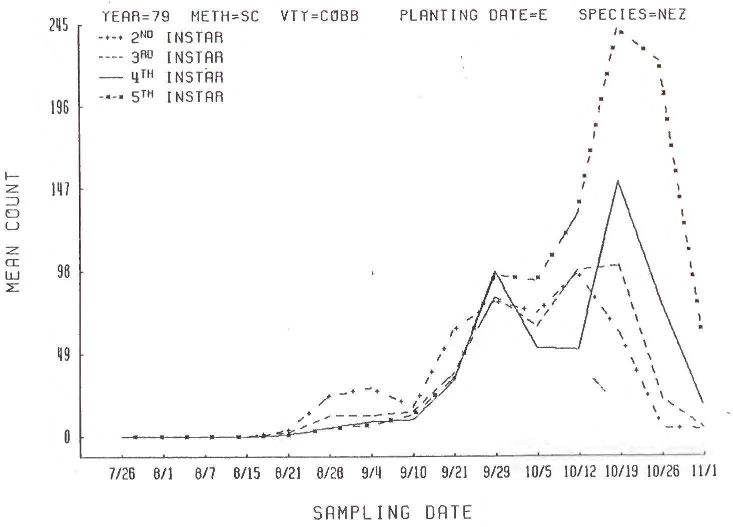

Fig. 25. Populations of *N. viridula* nymphs collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1979.

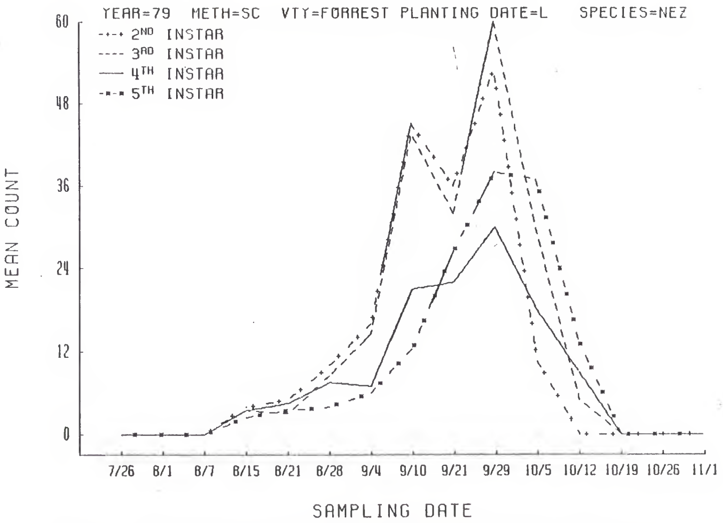

Fig. 26.. Populations of *N. viridula* nymphs collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1979.

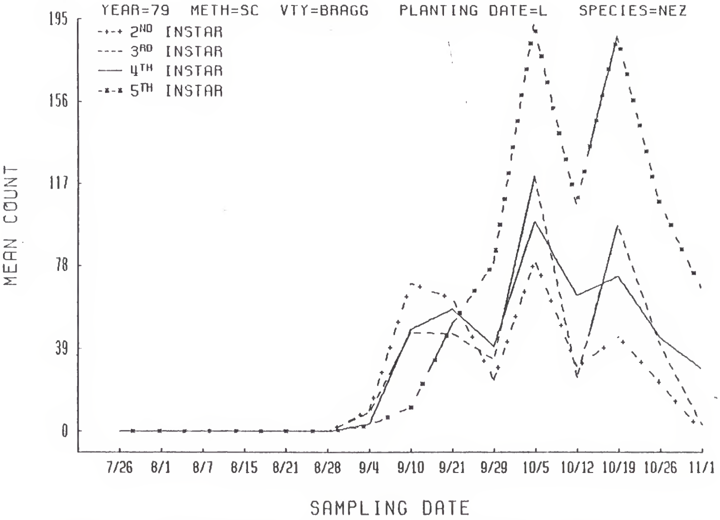

Fig. 27. Populations of *N. viridula* nymphs collected by ground cloth on late-planted-Bragg variety. Quincy, Florida, 1979.

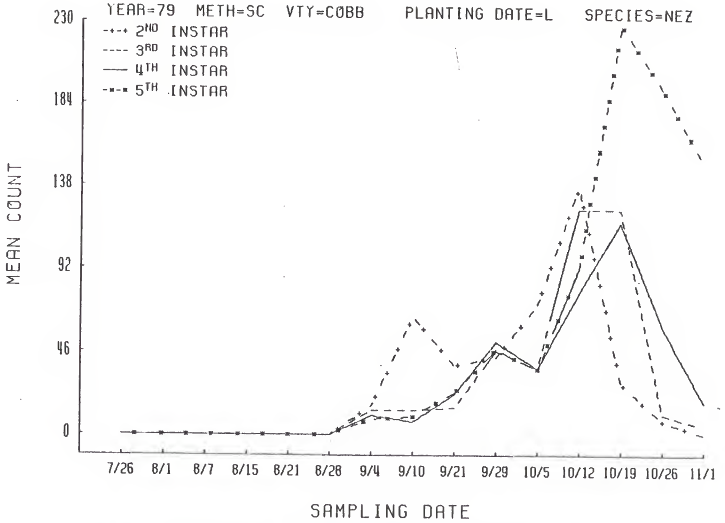

Fig. 28.. Populations of *N. viridula* nymphs collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1979.

no significant differences (P 0.05) occurred between planting dates for any nymphal stage. No significant (P 0.05) variety x planting date interaction was detected.

A. hilare Adults

Populations of *A. hilare* females sampled in 1977, 1978, and 1979 are shown in Figs. 29 through 42. Results of statistical analyses are shown in Table 2.

In 1977, no significant differences ($P>0.05$) in adult populations were detected between Forrest and Bragg varieties in the first sampling period. However, significant varietal differences were detected in the second sampling period for females and males ($P<0.01$ and $P<0.05$, respectively) and in the third sampling period for both sexes ($P<0.05$). No significant ($P>0.05$) planting date effects or variety x planting date interactions were detected.

In 1979, significant differences ($P<0.05$) were observed for both sexes among Forrest, Bragg and Cobb varieties in all three sampling periods. Significant differences between planting dates were observed for both sexes in the first ($P<0.01$) and second sampling period ($P<0.01$ for females, $P<0.05$ for males). No significant planting date effects ($P>0.05$) were observed in the third sampling period. No significant ($P>0.05$) variety x planting date interactions occurred in any of the three sampling periods.

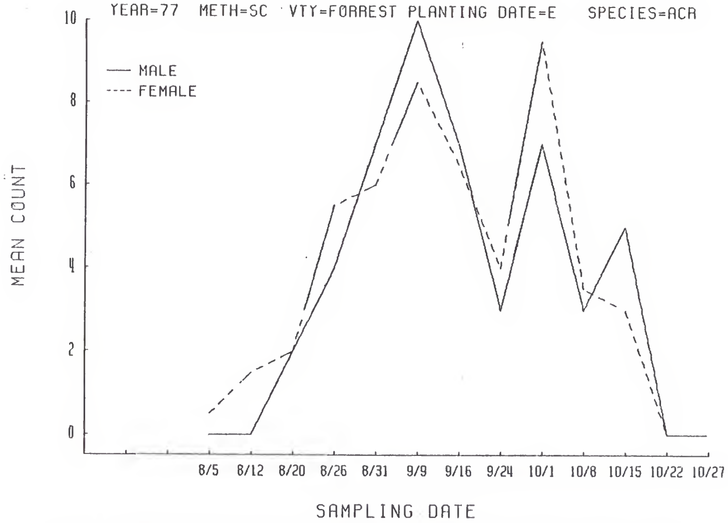

Fig. 29. Populations of *A. hilare* adults collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1977.

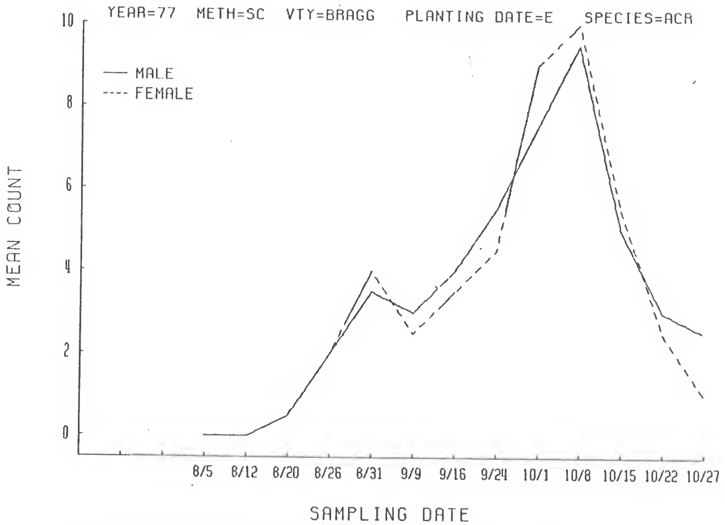

Fig. 30. Populations of *A. hilare* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida 1977.

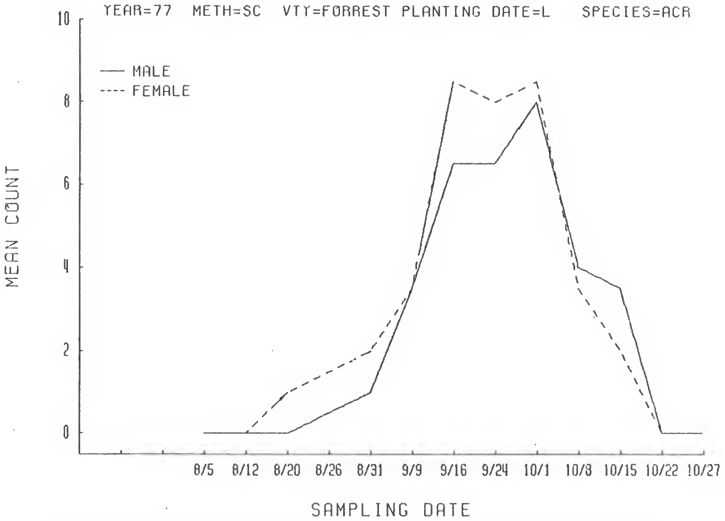

Fig. 31. Populations of *A. hilare* adults collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1977.

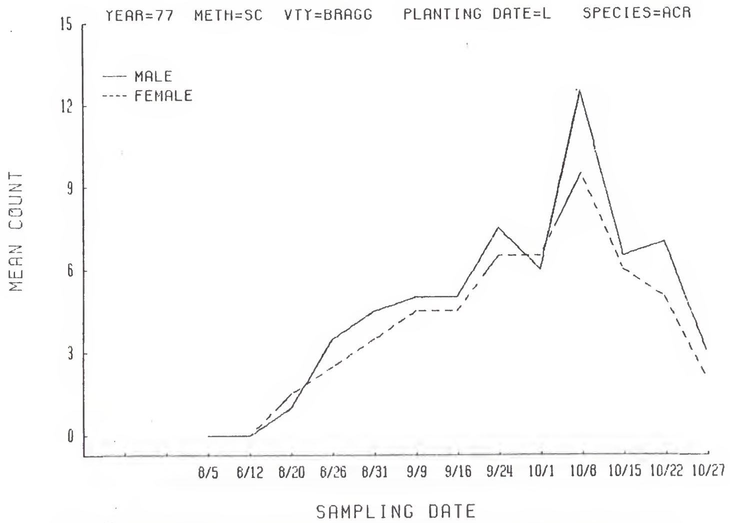

Fig. 32. Populations of *A. hilare* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1977.

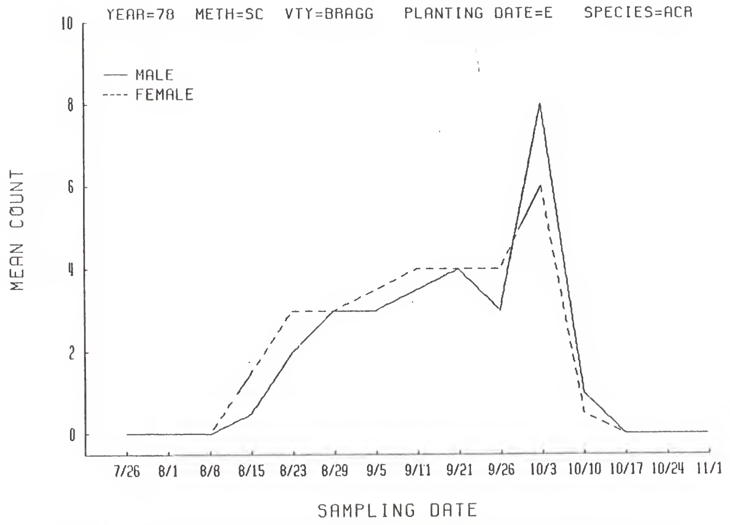

Fig. 33. Populations of *A. hilare* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1978.

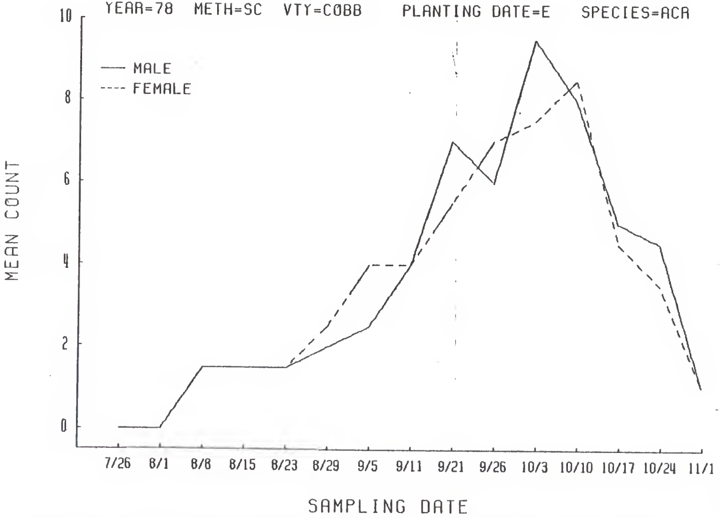

Fig. 34. Populations of *A. hilare* adults collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1978.

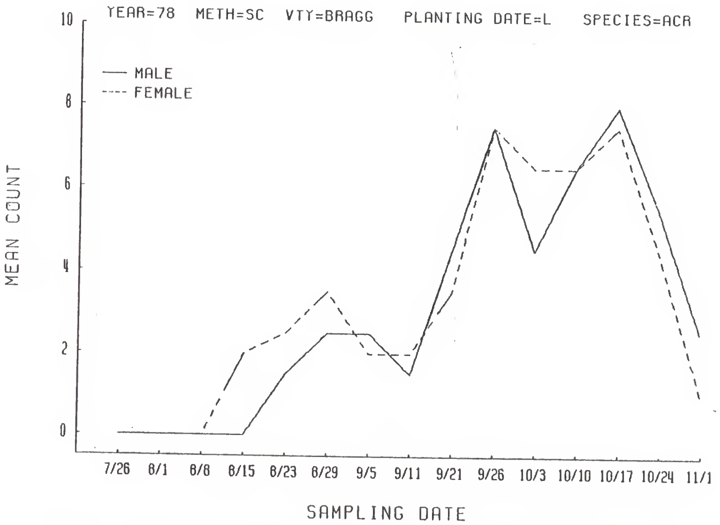

Fig. 35. Populations of *A. hilare* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1978.

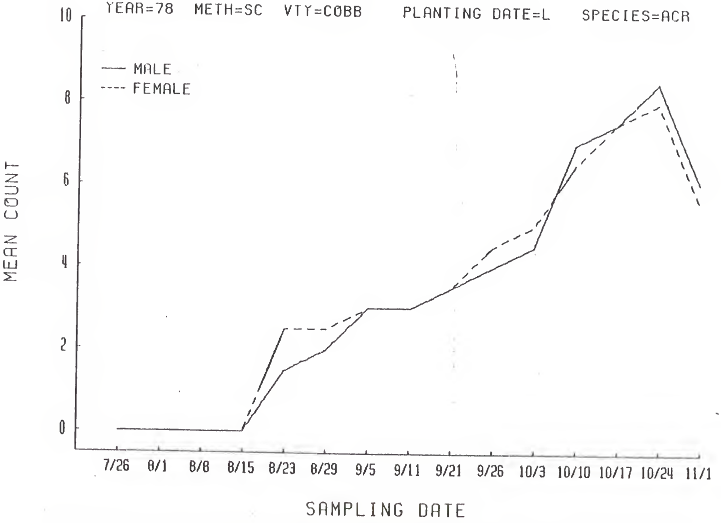

Fig. 36. Populations of *A hilare* adults collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1978.

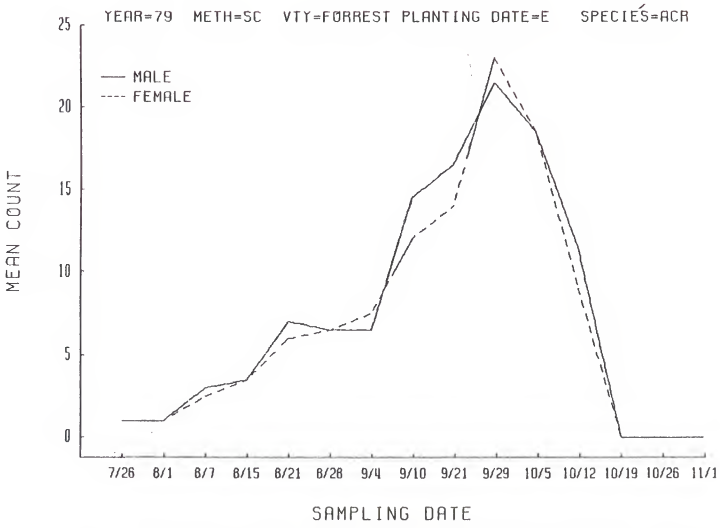

Fig. 37. Populations of *A. hilare* adults collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1979.

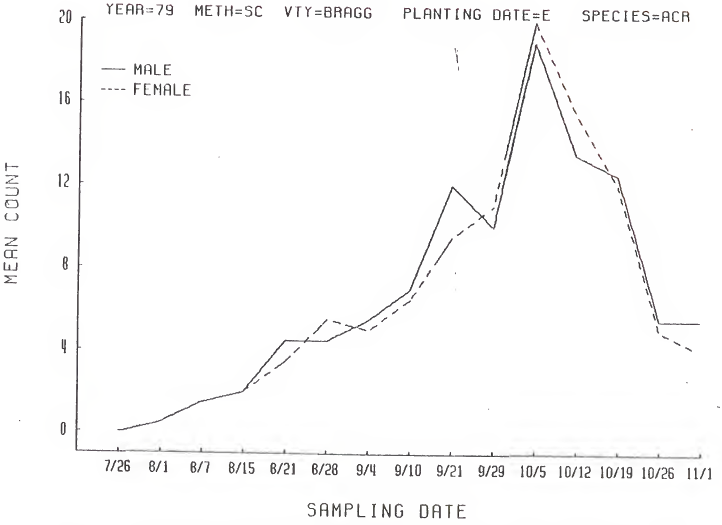

Fig. 38. Populations of *A. hilare* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1979.

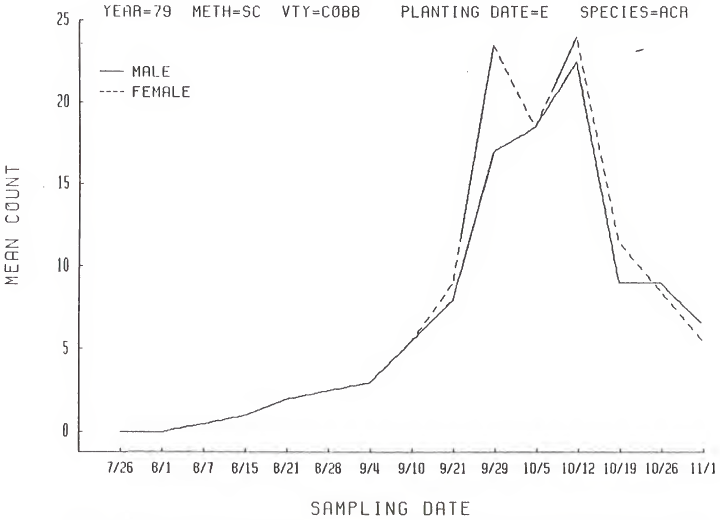

Fig. 39. Populations of *A. hilare* adults collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1979.

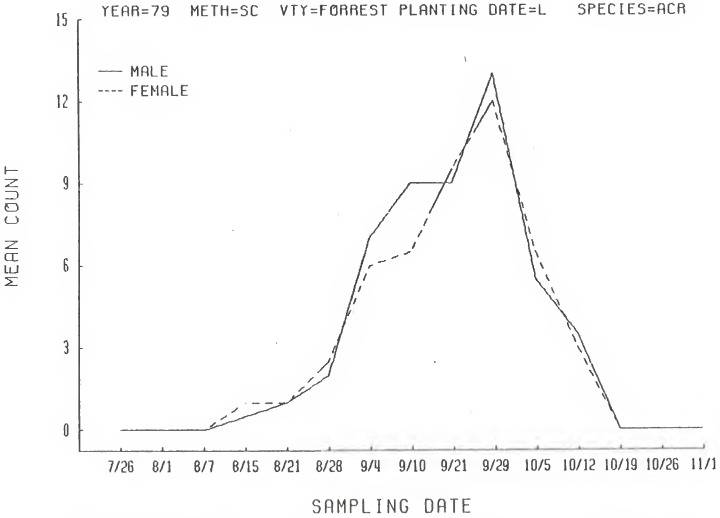

Fig. 40. Populations of *A. hilare* adults collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1979.

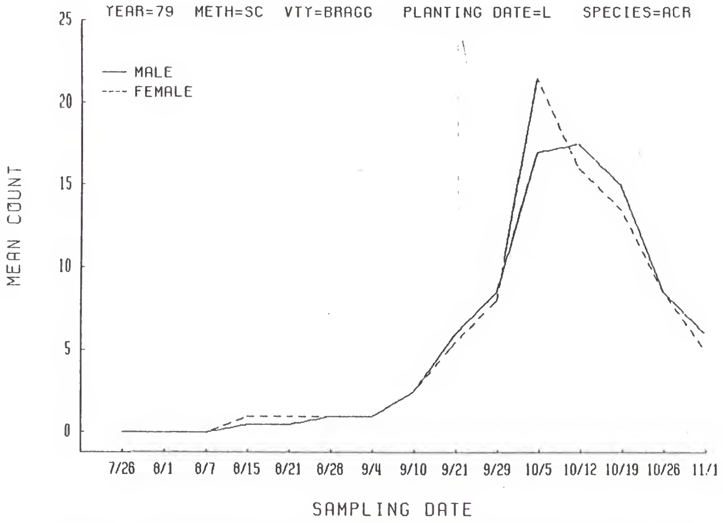

Fig. 41. Populations of *A. hilare* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1979.

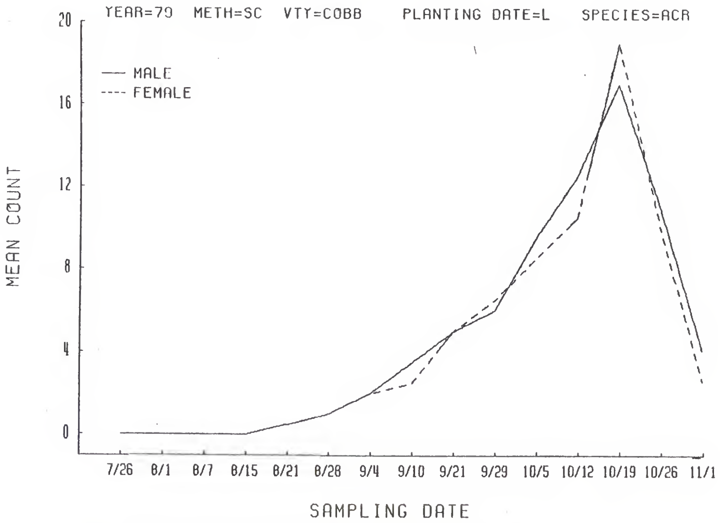

Fig. 42. Populations of *A. hilare* adults collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1979.

Table 2. Results of analyses of variance for *A. hilare* concerning variety and planting date effects and variety x planting date interaction.

Year	Period	First		Second			Third	
1977	Date	8/5 to 8/20		8/26 to 9/24			10/1 to 10/27		
State	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	Pd.xVty
Female	NS	NS	NS	NS	**	**	NS	*	NS
Male	NS	NS	NS	NS	*	*	NS	*	NS
Fifth	NS	NS	NS	NS	*	**	NS	*	NS
Fourth	NS	NS	NS	NS	NS	NS	NS	*	NS
Third	NS	NS	NS	NS	NS	NS	NS	*	NS
Second	NS	NS	NS	NS	NS	NS	NS	*	NS
1978	Date	7/26 to 8/23		8/29 to 9/26			10/3 to 11/1		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	Pd.xVty
Female	NS	NS	NS	NS	NS	NS	NS	NS	NS
Male	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fifth	NS	NS	NS	**	NS	NS	NS	NS	NS
Fourth	**	**	**	**	NS	NS	NS	NS	NS
Third	**	**	**	**	NS	NS	*	NS	NS
Second	**	**	**	**	NS	NS	*	NS	NS
1979	Date	7/26 to 8/21		8/28 to 9/29			10/5 to 11/1		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. Date	Vty	Pd.xVty
Female	**	*	NS	**	*	NS	NS	*	NS
Male	**	*	NS	*	*	NS	Ns	**	NS
Fifth	*	NS	NS	**	*	NS	NS	**	NS
Fourth	*	NS	NS	*	NS	NS	NS	NS	NS
Third	*	NS	NS	*	NS	NS	NS	NS	NS
Second	*	NS	NS	**	NS	NS	NS	NS	NS

NS = Nonsignificant ($P > 0.05$)

* = Significant ($P < 0.05$)

** = Highly significant ($P < 0.01$)

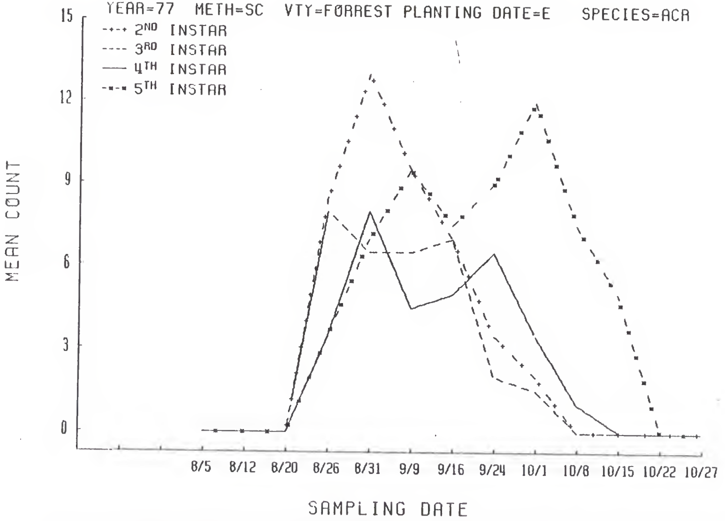

Fig. 43. Populations of *A. hilare* nymphs collected by ground cloth on early planted planted Forrest variety. Quincy, Florida, 1977.

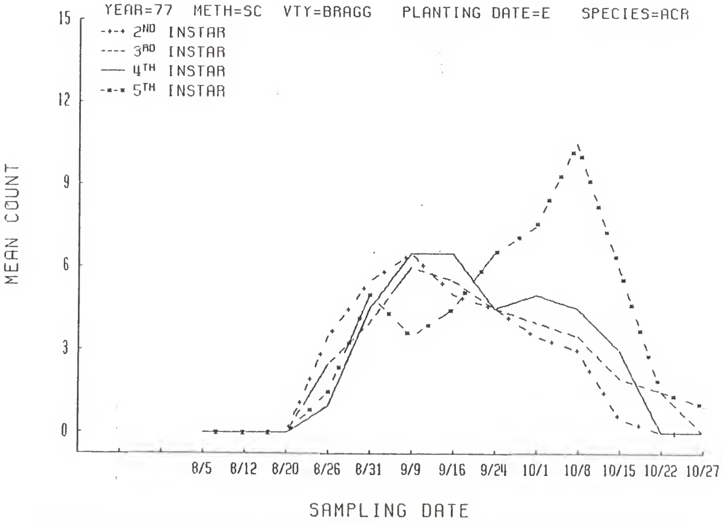

Fig. 44. Populations of *A. hilare* numphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1977.

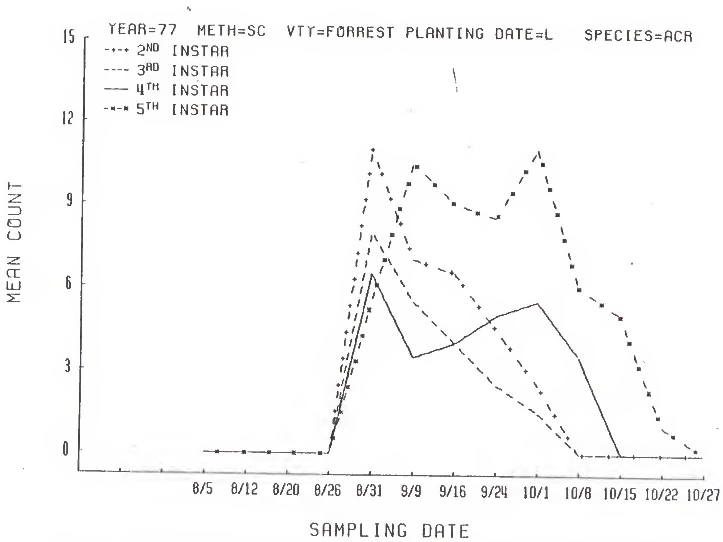

Fig. 45. Populations of *A. hilare* nymphs collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1977.

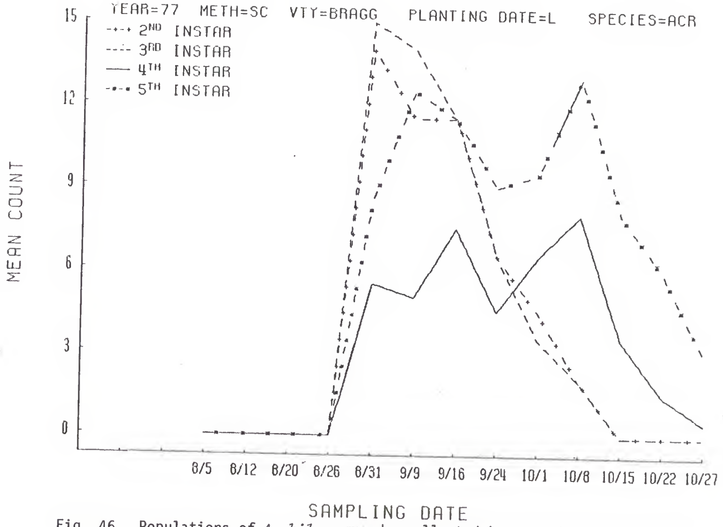

Fig. 46. Populations of *A. hilare* mymphs collected by ground cloth on late-Bragg variety. Quincy, Florida, 1977.

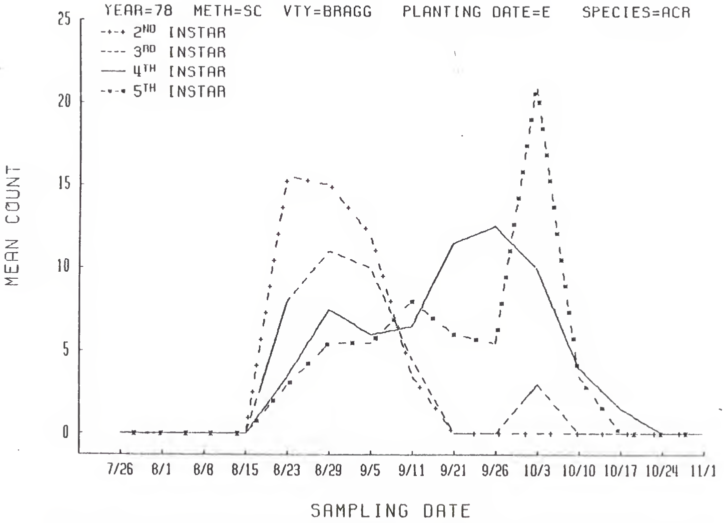

Fig. 47. Populations of *A. hilare* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1978.

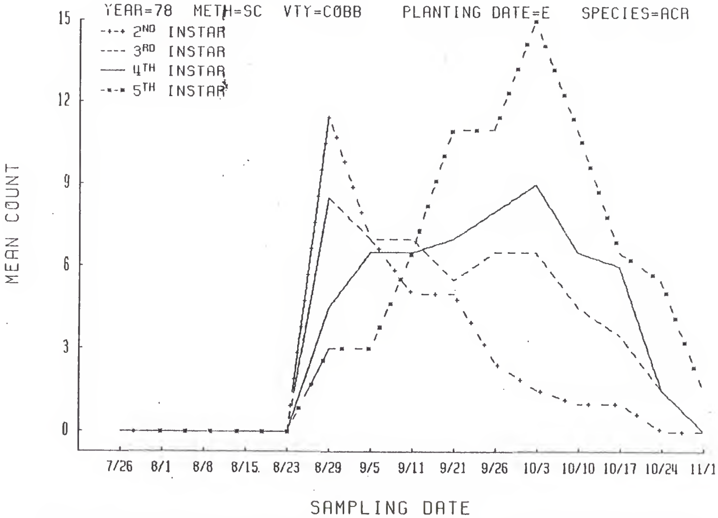

Fig. 48. Populations of *A. hilare* nymphs collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1978.

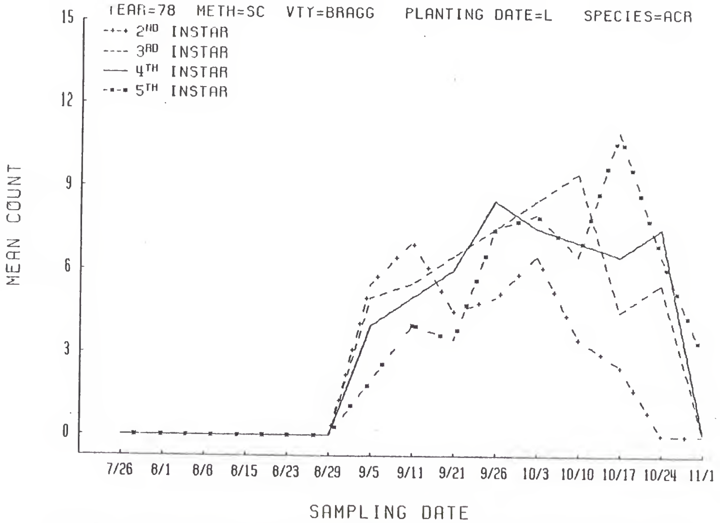

Fig. 49. Populations of *A hilare* nymphs collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1978.

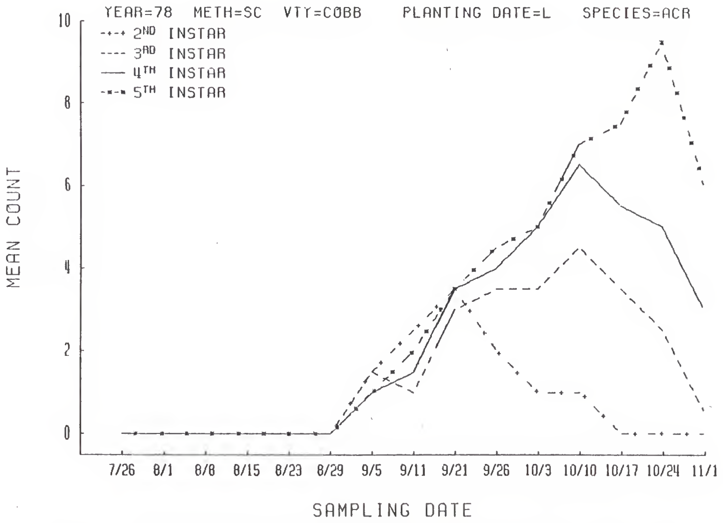

Fig. 50. Populations of *A. hilare* nymphs collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1978.

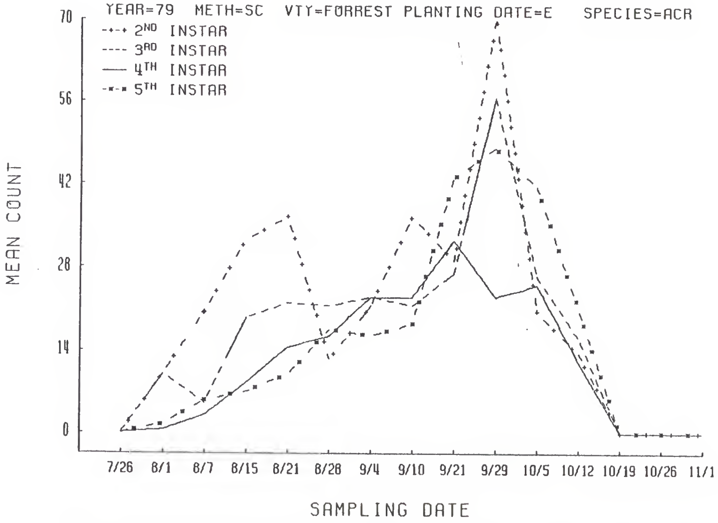

Fig. 51. Populations of *A. hilare* nymphs collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1979.

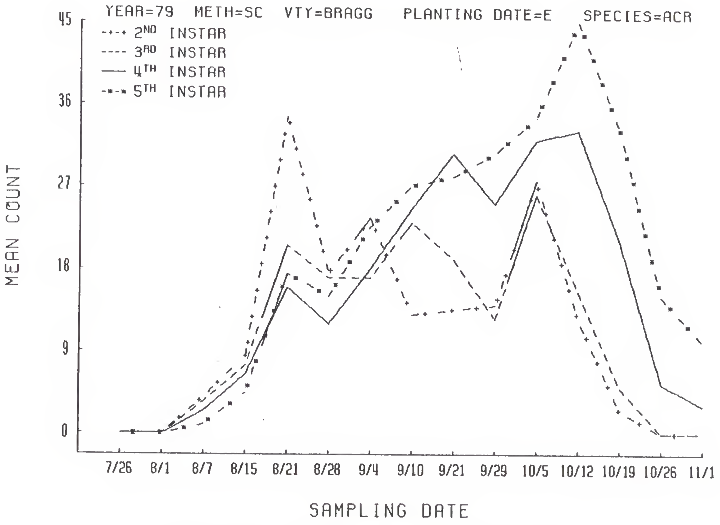

Fig. 52. Populations of *A. hilare* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1979.

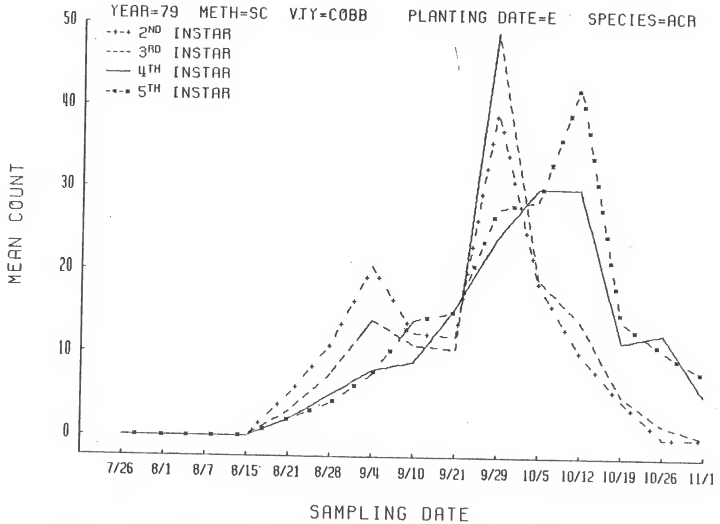

Fig. 53. Populations of *A. hilare* nymphs collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1979.

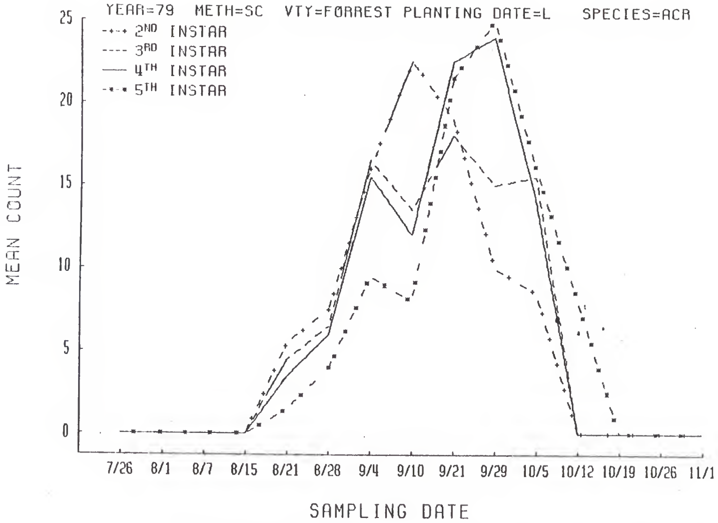

Fig. 54. Populations of *A. hilare* nymphs collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1979.

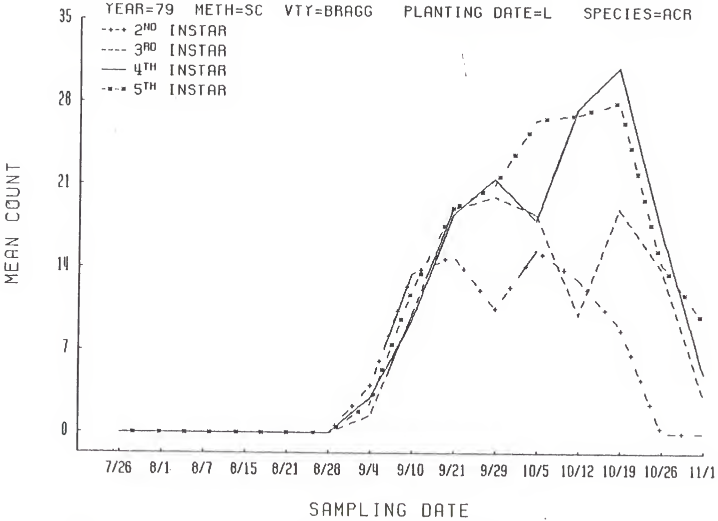

Fig. 55. Populations of *A. hilare* nymphs collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1979.

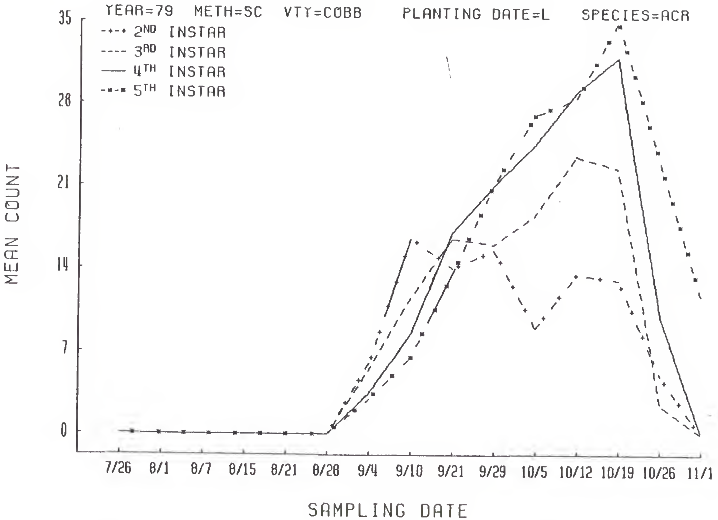

Fig. 56. Populations of *A. hilare* nymphs collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1979.

A. hilare Nymphs

Populations of *A. hilare* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 43 through 56. Results of statistical analyses are shown in Table 2.

In 1977, no significant differences ($P>0.05$) were detected in nymphal populations between varieties during the first sampling period. In the second sampling period only populations of the fifth instar differed significantly ($P<0.05$) among varieties. In the third sampling period populations of all nymphal stages differed significantly ($P<0.05$) among varieties. No significant ($P>0.05$) planting date effects were observed for any nymphal stage in any sampling period. Significant ($P<0.05$) variety times planting date interactions occurred only in the fifth instar nymphs during the second sampling period.

In 1978, no significant ($P>0.05$) differences were detected between varieties for any nymphal stage in the second or third sampling period. However, varietal differences were significant ($P<0.01$) for second, third, and fourth instars only in the first sampling period. In the first sampling period, only second, third, and fourth instars differed significantly ($P<0.01$) between planting dates. In the second sampling period all nymphal stages and in the third sampling period, second and third stage nymphs differed significantly ($P<0.01$ and $P<0.05$, respectively) between planting dates. Significant ($P<0.01$) variety x planting date interactions occurred only in the first sampling period for second, third, and fourth instars.

In 1979, no significant differences ($P>0.05$) among varieties were detected for any nymphal stage in the first sampling period. In the second and third sampling periods, varietal differences occurred only for the fifth instar ($P<0.05$ and $P<0.01$, respectively). Significant ($P<0.05$) planting date differences occurred for all stages in the first sampling period. In the second sampling period, second and fifth stages, and third and fourth stages also differed significantly ($P<0.01$ and $P<0.05$, respectively) between planting dates. No significant ($P>0.05$) planting date differences were detected for any nymphal stage in the third sampling period. No significant ($P>0.05$) variety times planting date interaction occurred in any sampling period.

E. servus Adults

Populations of *E. servus* adults sampled in 1977, 1978, and 1979 are shown in Figs. 57 through 70. Results of statistical analyses are shown in Table 3.

No significant differences ($P>0.05$) in adult populations were detected between Forrest and Bragg varieties in the first, second, and third sampling periods, in 1977.

No significant differences ($P>0.05$) for both sexes, concerning planting date or variety x planting date interactions were found in 1977.

No significant variety or planting date effects or variety x planting date interactions were observed during the first sampling period in 1978. However, significant differences between planting dates were observed for both sexes in the second ($P<0.05$) and third sampling period ($P<0.01$). In the third sampling period, adult populations differed significantly ($P<0.05$) among varieties.

In 1979, significant differences between planting dates were observed for both sexes in the first sampling period ($P<0.05$), but no significant planting date effects ($P>0.05$) were observed in the second and third sampling periods.

Significant varietal differences for adult populations were observed in the second ($P<0.05$) and third ($P<0.01$) sampling periods of 1979, but no significant ($P>0.05$) variety x planting date interactions occurred in any of the three sampling periods.

E. servus Nymphs

Populations of *E. servus* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 71 through 84. Results of statistical analyses are presented in Table 3.

In 1977, no significant variety or planting date effects or variety x planting date interactions were observed to the fifth nymphal stage. No significant differences ($P>0.05$) were detected in nymphal populations concerning the planting date effects or variety or variety x planting date interactions during the first sampling period. Planting date effects were observed for fourth, third ($P<0.01$) and second ($P<0.05$) instars during the second sampling period; however, it was not significant ($P>0.05$) in fourth, significant ($P<0.05$) in third, and significant ($P<0.01$) in second nymphal stages during the third sampling period.

Varietal differences were significant ($P<0.05$) for fourth and highly significant ($P<0.01$) to third and second instars in the second sampling period, but it was highly significant ($P<0.01$) for the fourth and second instars, and significant ($P<0.05$) for the third instar in the third sampling period of 1977.

No significant variety or planting date effects or variety x planting date interaction were found in nymphal populations in the first sampling period of 1978. Planting date effects were significant ($P<0.05$ to the fifth and $P<0.01$ in the third and fourth instars) except for the second ($P>0.05$) during the second sampling period. It was significant in all nymphal stages ($P>0.05$ for the second and third, and $P<0.01$ for the fourth and fifth instars) in the third sampling period. No significant differences ($P>0.05$) among varieties were observed for any nymphal stage in the second sampling period. It was detected for the fifth ($P<0.05$) and fourth ($P<0.01$) instars (second and third were not significant, $P>0.05$) in the third sampling period. No significant ($P>0.05$) variety x planting date interactions occurred in any sampling period.

In 1979, no significant differences ($P>0.05$) among varieties were detected for any nymphal stage in the first and second sampling period. In the third sampling period, significant differences were observed for the fifth ($P<0.01$) and for the fourth ($P<0.05$), but not for the second and third instars ($P>0.05$). In the first sampling period only the fourth and fifth instars differed significantly ($P<0.05$) between planting dates. In the second sampling period only the second and third instars differed significantly ($P<0.01$) between planting dates. There were no planting date effects for all nymphal stages in the third sampling period. No significant ($P>0.05$) variety x planting date interaction occurred in any of the three sampling periods.

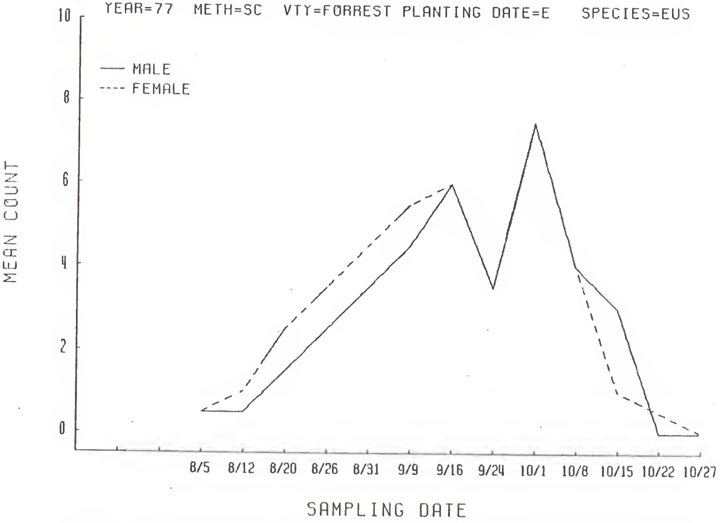

Fig. 57. Populations of *E. servus* adults collected by ground cloth on early-planted Forrest variety. Quincy, Florida. 1977.

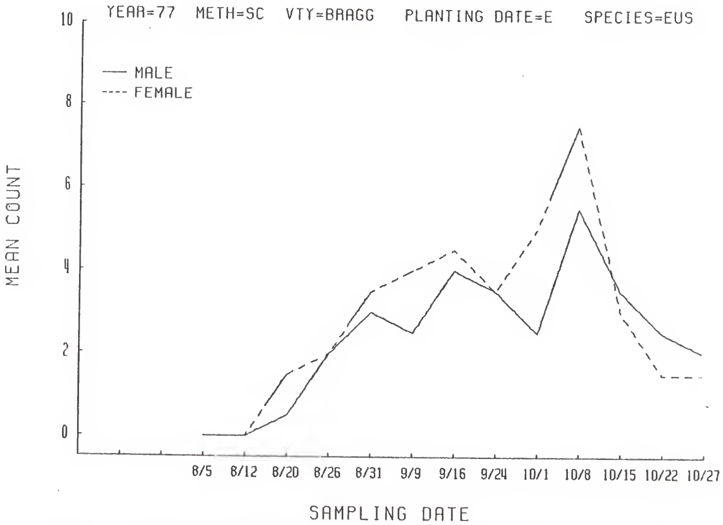

Fig. 58. Populations of *E. servus* adults collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1977.

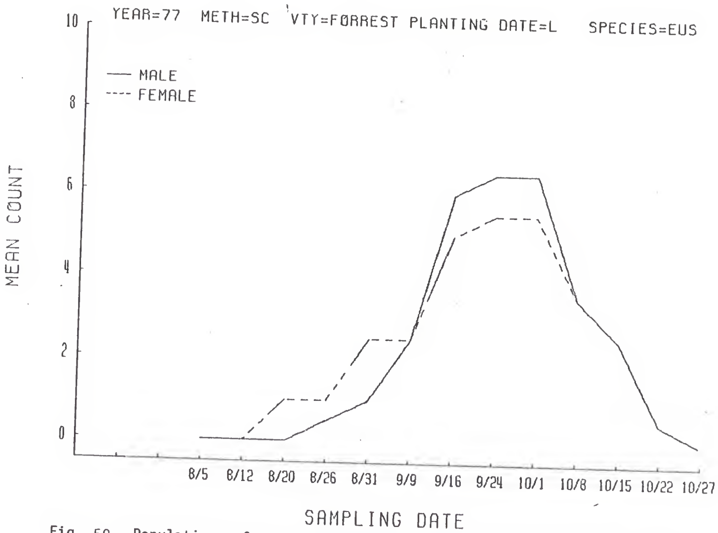

Fig. 59. Populations of *E. servus* adults collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1977.

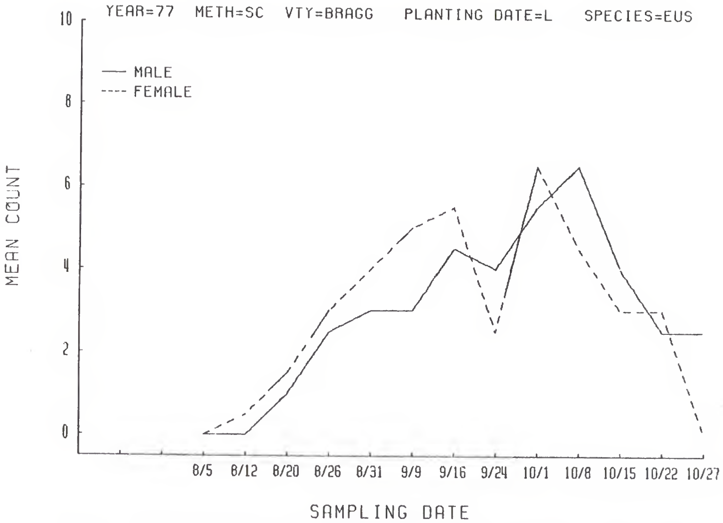

Fig. 60. Populations of *E. servus* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida 1977.

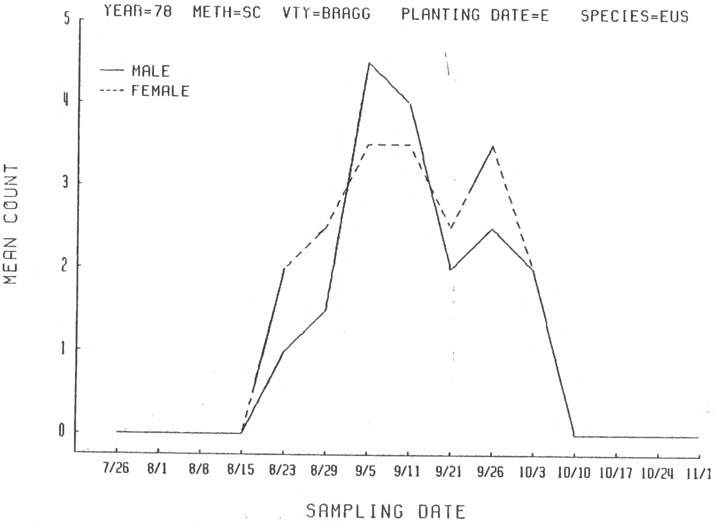

Fig. 61. Populations of *E. servus* adults collected by ground cloth on early-planted Bragg variety.. Quincy, Florida, 1978.

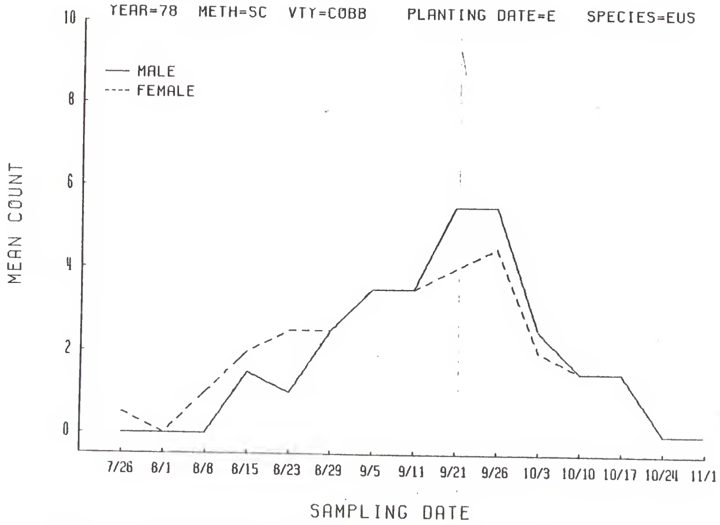

Fig. 62. Populations of *E. servus* adults collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1978.

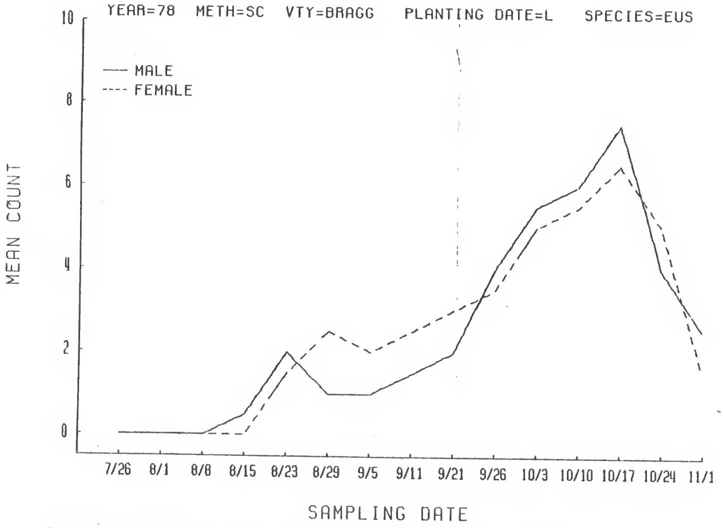

Fig. 63. Populations of *E. servus* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1978.

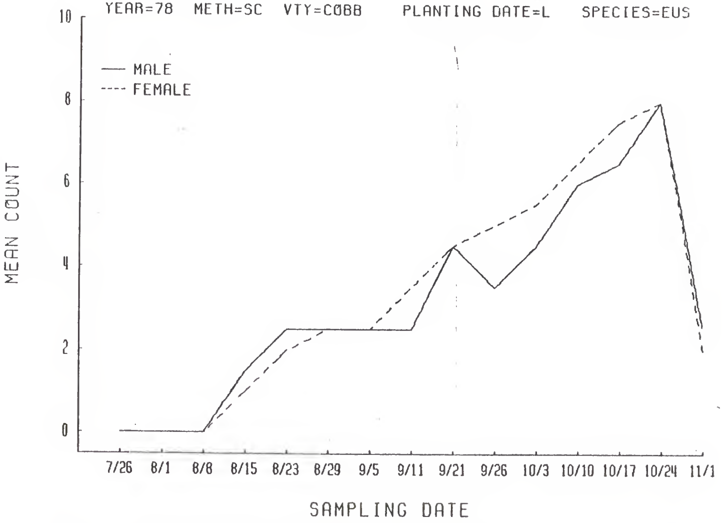

Fig. 64. Populations of *E. servus* adults collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1978.

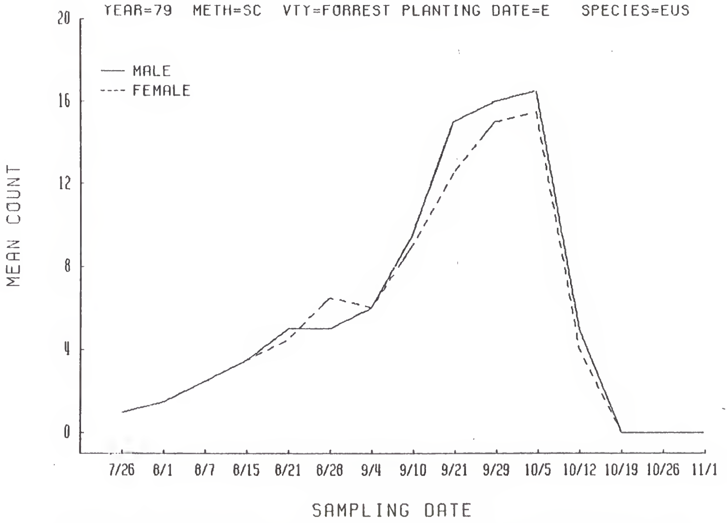

Fig. 65. Populations of *E. servus* adults collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1979.

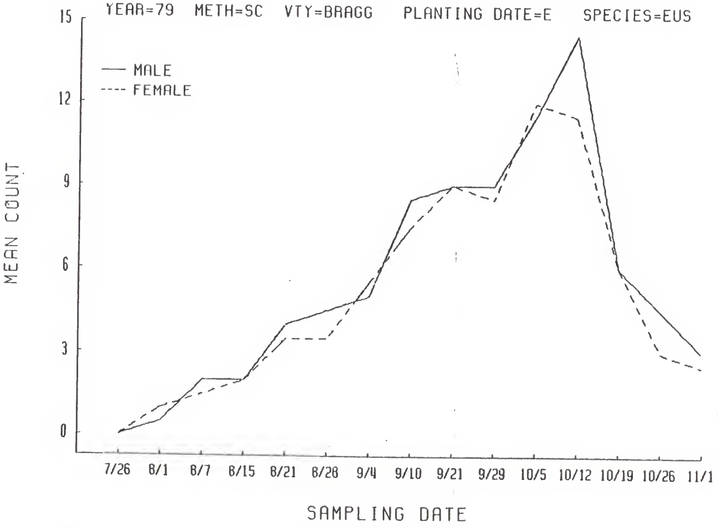

Fig. 66. Populations of *E. servus* adults collected by ground cloth on early-planted Bragg cariety. Quincy, Florida, 1979.

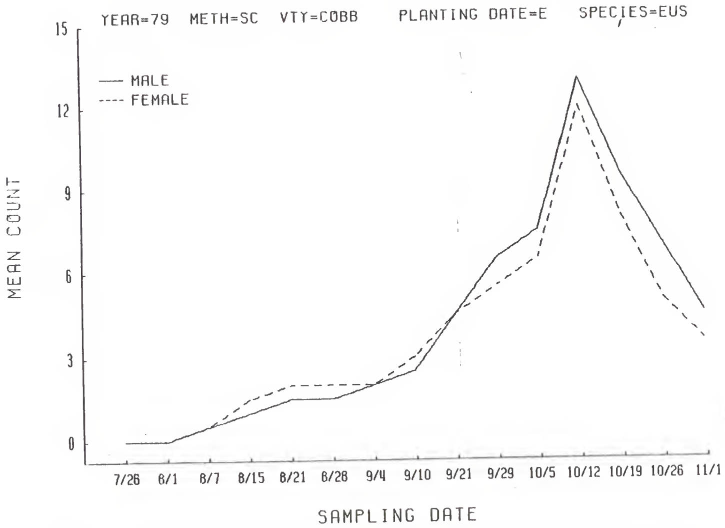

Fig. 67. Populations of *E. servus* adults collected on ground cloth on early-planted Cobb variety. Quincy, Florida, 1979.

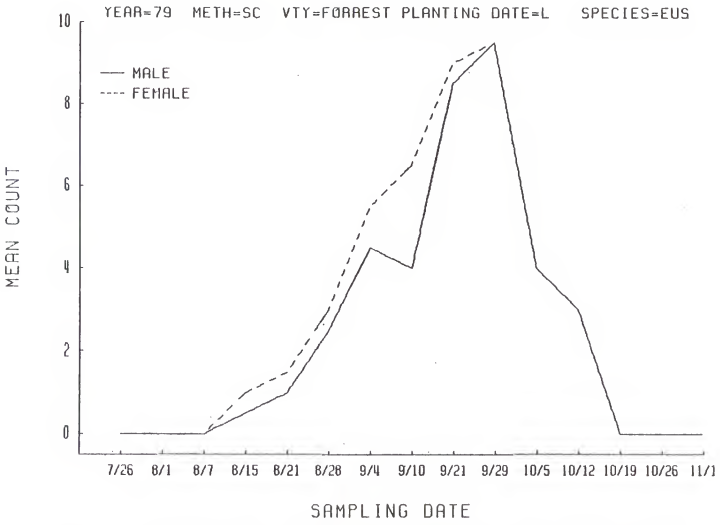

Fig. 68. Populations of *E. servus* adults collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1979.

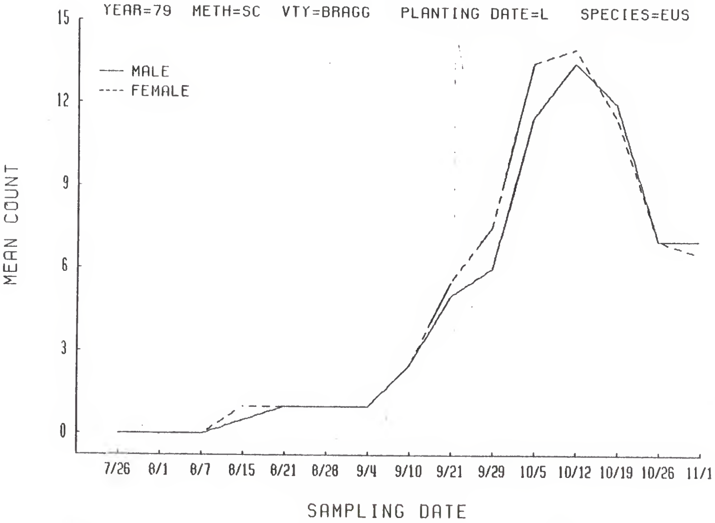

Fig. 69. Populations of *E. servis* adults collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1979.

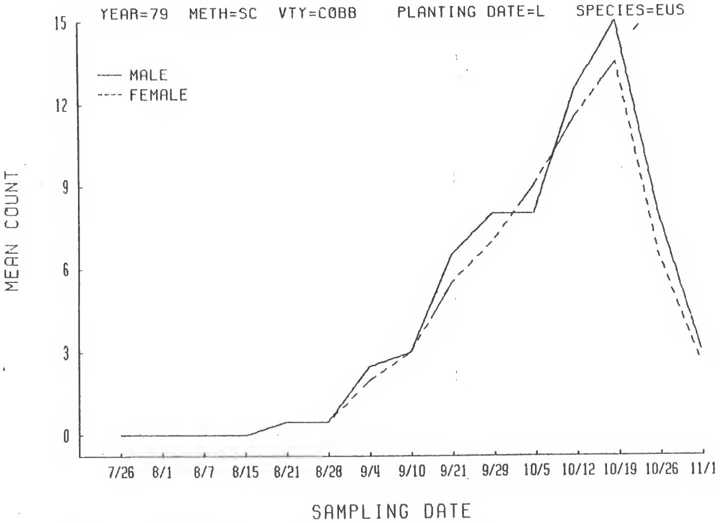

Fig. 70. Populations of *E. servus* adults collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1979.

Table 3. Results of analyses of variance for *E. servus* concerning variety and planting date effects and variety x planting date interaction.

Year	Period	First			Second			Third		
1977	Date	8/5 to 8/20			8/26 to 9/24			10/1 to 10/27		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	PdxVty
Female	NS	NS	NS	NS	NS	NS	NS	NS	NS
Male	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fifth	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fourth	NS	NS	NS	**	*	NS	NS	**	*
Third	NS	NS	NS	**	**	**	*	*	**
Second	NS	NS	NS	*	**	**	**	**	*
1978	Date	7/26 to 8/23			8/29 to 9/26			10/3 to 11/1		
Stage	P. date	Vty	Pd.xVty	P. date	Vty	PdxVty	P. date	Vty	PdxVty
Female	NS	NS	NS	*	NS	NS	**	*	NS
Male	NS	NS	NS	*	NS	NS	**	*	NS
Fifth	NS	NS	NS	*	NS	NS	**	*	NS
Fourth	NS	NS	NS	**	NS	NS	**	**	NS
Third	NS	NS	NS	**	NS	NS	*	NS	NS
Second	NS	NS	NS	NS	NS	NS	*	NS	NS
1979	Date	7/26 to 8/21			8/28 to 9/29			10/5 to 11/1		
Stage	P. date	Vty	PdxVty	P. date	Vty	PdxVty	P. date	Vty	PdxVty
Female	*	NS	NS	NS	*	NS	NS	**	NS
Male	*	NS	NS	NS	*	NS	NS	**	NS
Fifth	*	NS	NS	NS	NS	NS	NS	**	NS
Fourth	*	NS	NS	NS	NS	NS	NS	*	NS
Third	NS	NS	NS	**	NS	NS	NS	NS	NS
Second	NS	NS	NS	**	NS	NS	NS	NS	NS

NS = Nonsignificant ($P > 0.05$)

* = Significant ($P < 0.05$)

** = Highly significant ($P < 0.01$)

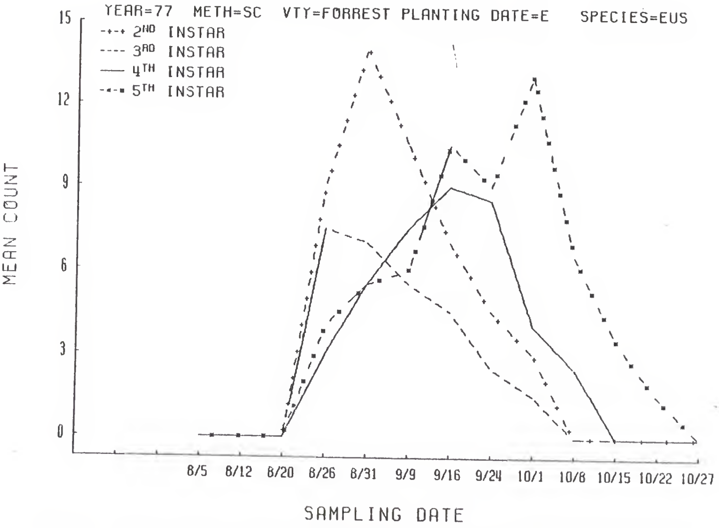

Fig. 71. . Populations of *E. servus* nymphs collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1977.

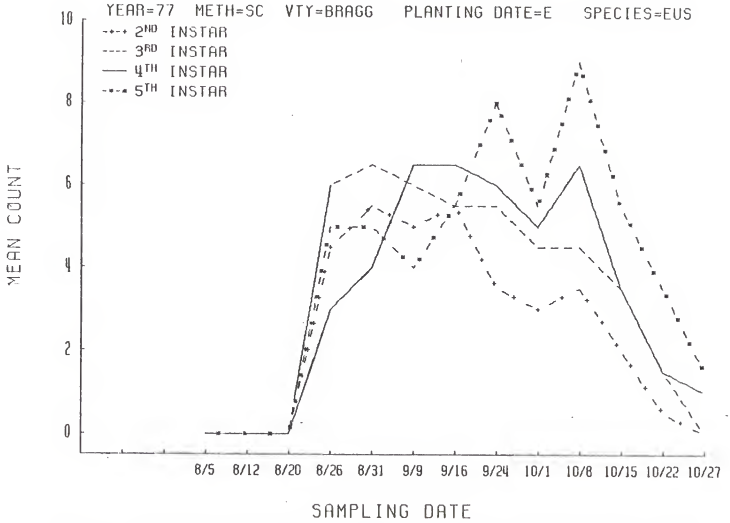

Fig. 72.. Populations of *E. servus* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1977.

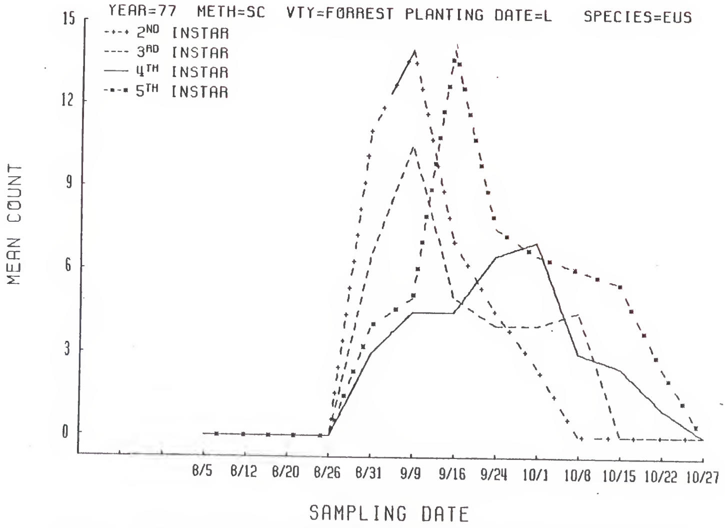

Fig. 73. Populations of *E. servus* nymphs collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1977.

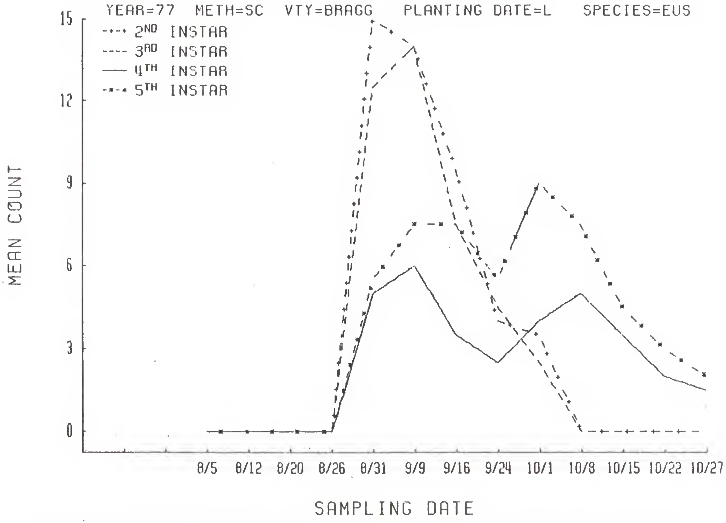

Fig. 74. Populations of *E. servus* nymphs collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1977.

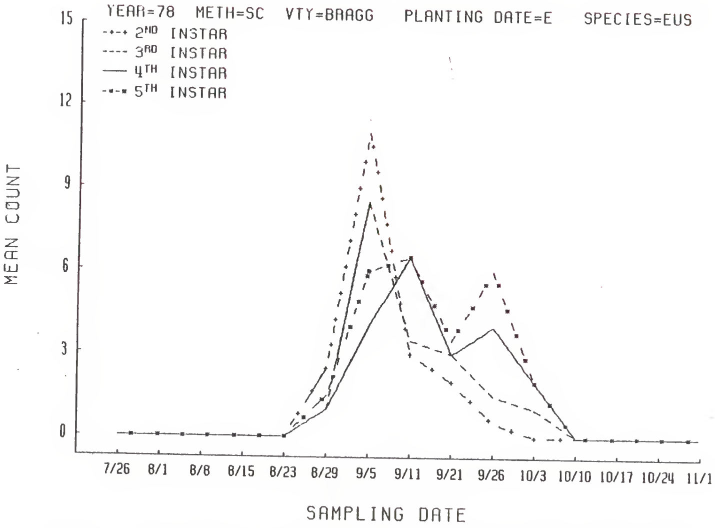

Fig. 75. Populations of *E. servus* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1978.

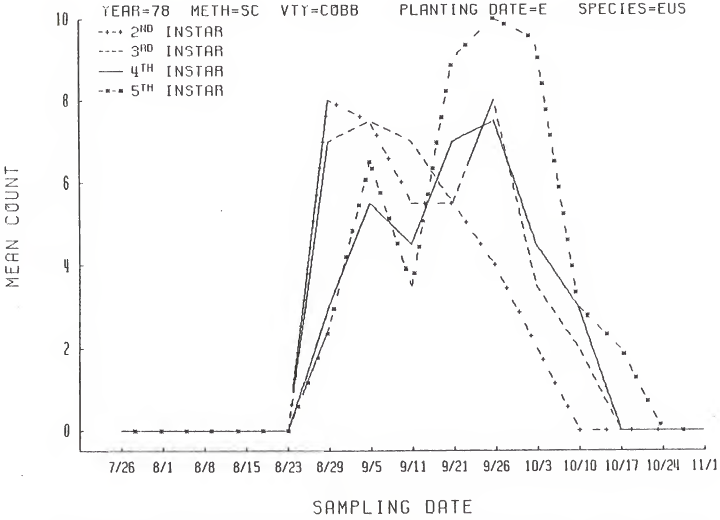

Fig. 76. Populations of *E. servus* nymphs collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1978.

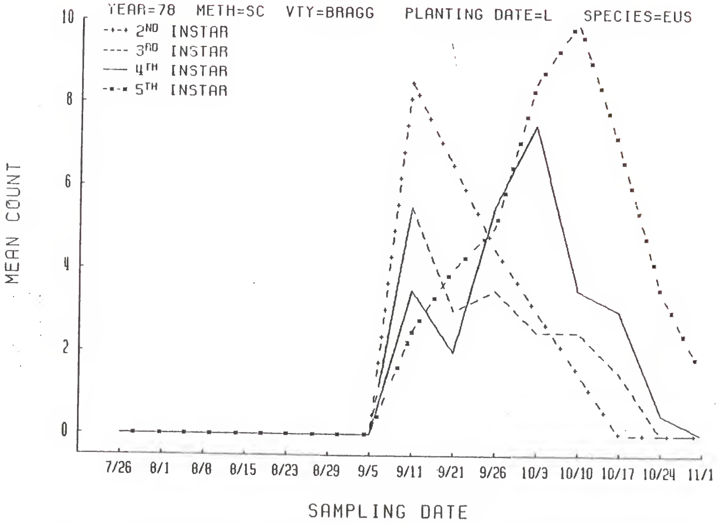

Fig. 77. Populations of *E. servus* nymphs collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1978.

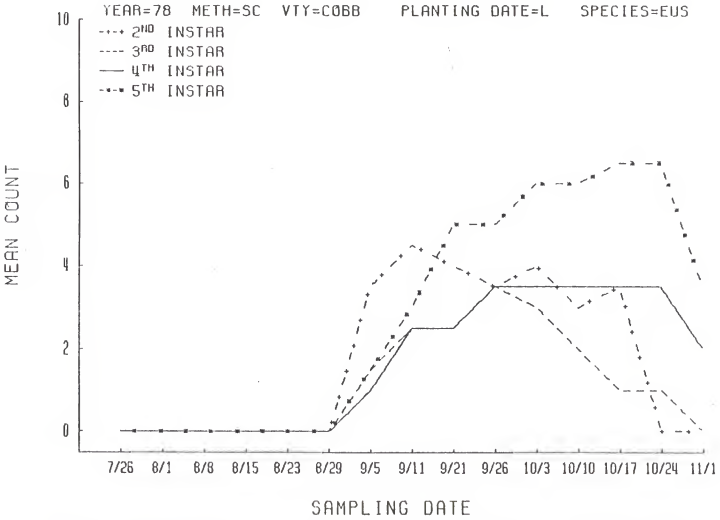

Fig. 78. Populations of *E. servus* nymphs collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1978.

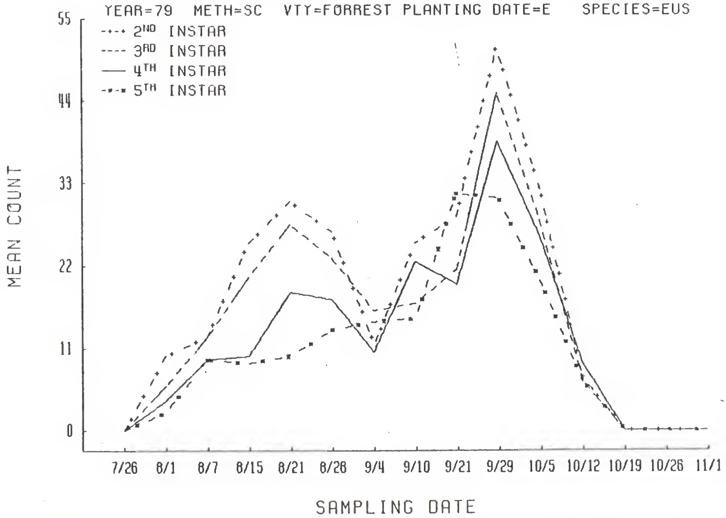

Fig. 79. Populations of *E. servus* nymphs collected by ground cloth on early-planted Forrest variety. Quincy, Florida, 1979.

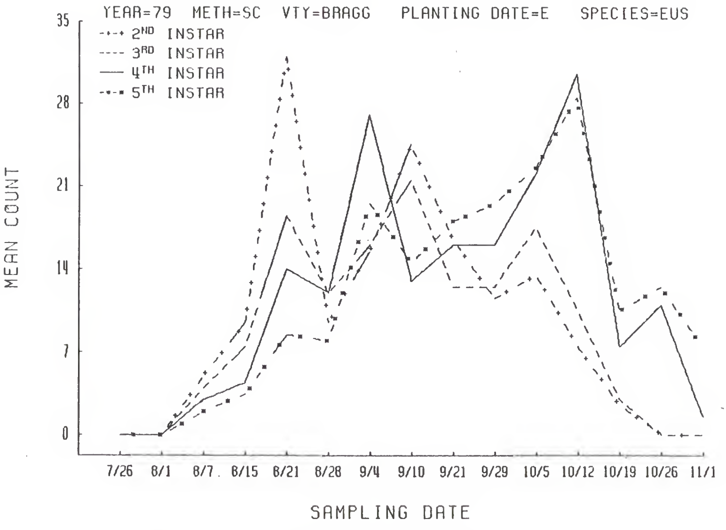

Fig. 80. Populations of *E. servus* nymphs collected by ground cloth on early-planted Bragg variety. Quincy, Florida, 1979.

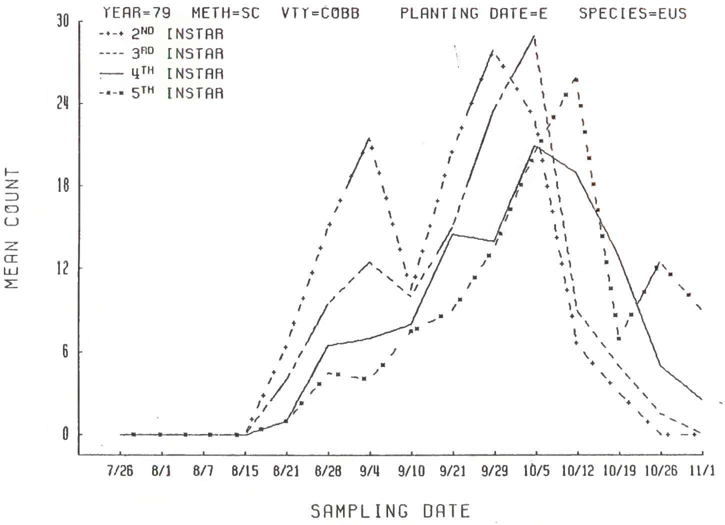

Fig. 81. Populations of *E. servus* nymphs collected by ground cloth on early-planted Cobb variety. Quincy, Florida, 1979.

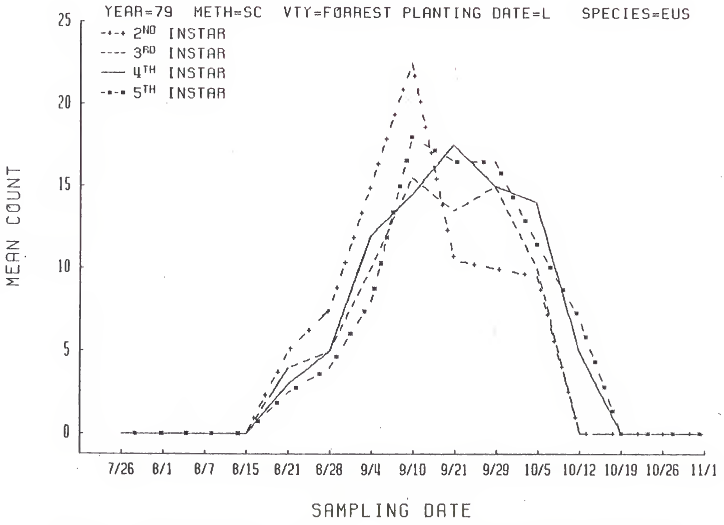

Fig. 82. Populations of *E. servus* nymphs collected by ground cloth on late-planted Forrest variety. Quincy, Florida, 1979.

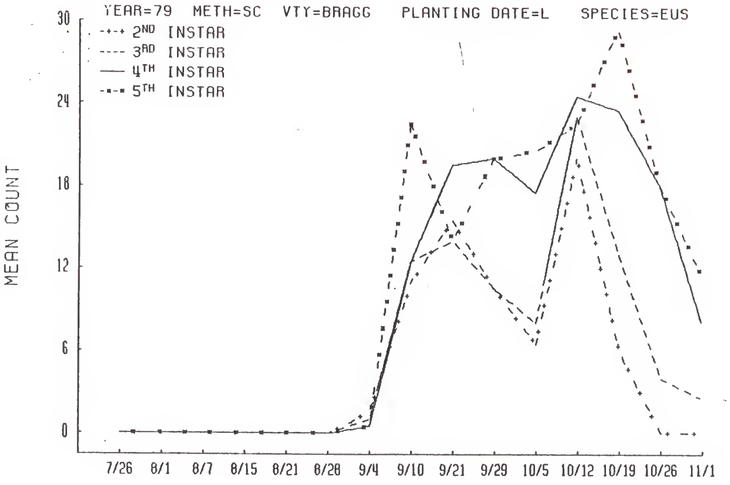

Fig. 83. Populations of *E. servus* nymphs collected by ground cloth on late-planted Bragg variety. Quincy, Florida, 1979.

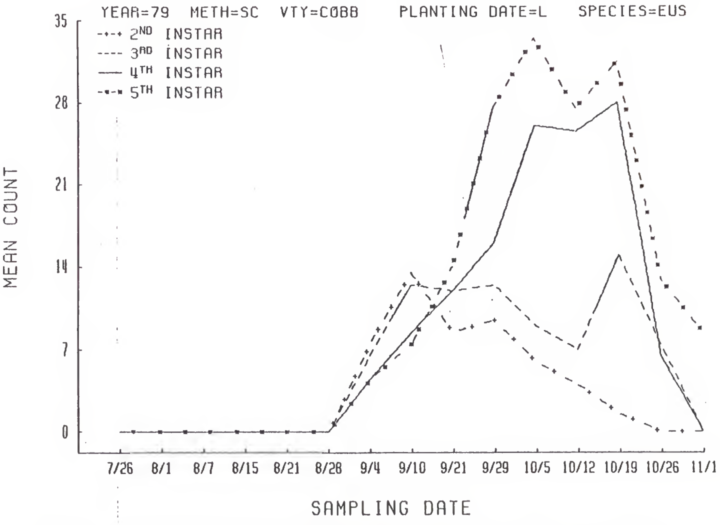

Fig. 84. Populations of *E. servus* nymphs collected by ground cloth on late-planted Cobb variety. Quincy, Florida, 1979.

Discussion

N. viridula Adults

Adults of *N. viridula* were not collected in any planting at the beginning of the first sampling period of 1977. By the end of the first sampling period on August 20, both sexes had invaded the early Forrest planting in sufficient numbers that statistical analyses indicated significantly larger numbers in the early date plantings and in the Forrest variety. In 1978, adults of this species were collected only in early-planted Bragg on the first sampling date. By the end of the first sampling period on August 23, sufficient numbers had invaded early plantings of both varieties that statistical analyses indicated significantly larger populations than in the later plantings. In 1979, no adults were collected in any planting on the first sampling date. Statistical analyses indicated that by the end of the first sampling period larger populations of both sexes were present in the earlier planting dates.

In the second sampling period in 1977 adults continued to increase disproportionately in early-planted Forrest as compared to other plantings. Since the earlier Forrest planting set pods before either of the Bragg plantings or the late-planted Forrest, these results confirm those of Newsom and Herzog (1977). They reported that adults of *N. viridula* were attracted to soybean plantings on which developing pods were first available. They further reported that this behavioral characteristic allows early plantings of early-maturing varieties, such as Forrest, to be used as trap crops.

In 1978 and 1979, adult populations continued to increase in the second sampling period. However, in 1978 no variety or planting date effects were detected. In 1979, both sexes were present in significantly greater numbers on Forrest than on either Bragg or Cobb, and on early than on late plantings.

Early in the third sampling period of both 1977 and 1979 plantings of Forrest began to mature, resulting in dispersal of adults into plantings of later-maturing varieties (Bragg and Cobb). It is this movement of adults that is prevented by judiciously timed insecticidal applications to trap plantings (Newsom and Herzog, 1977). In 1977, both sexes were significantly higher in Bragg than in Forrest varieties. In 1978 no variety or planting date effects could be detected. In 1979, early plantings supported the largest populations of adults. Cobb supported significantly higher, Forrest significantly lower adult populations than Bragg.

In 1977 adult populations peaked on September 24 in early-planted Forrest, October 1 (females) and October 8 (males) in late-planted Forrest, October 8 in early-planted Bragg, and October in late-planted Bragg; in 1978, October 3 in early-planted Bragg, October 10 in late-planted Bragg and late-planted Cobb, and October 17 in early-planted Cobb; in 1979, September 29 in early-planted Forrest, September 29 (females) and October 5 (males) in late-planted Forrest, October 19 (females) and October 26 (males) in late-planted Bragg, and October 26 in early-planted Bragg and both plantings of Cobb.

Examination of the adult population curves for many of the plantings in all three years of the study reveals an interesting difference in the behavior of females and males. In many cases, females invaded earlier and in larger numbers than did males. This confirms observations of Herzog (personal communication) and others that colonizing females are usually mated and probably begin ovipositing almost immediately. Likewise, females often disperse from a particular planting earlier and at a faster rate than males.

N. viridula Nymphs

In the first sampling period of 1977, no significant varietal effect was found on any of the nymphal stages. Significantly more nymphs of all stages were found in the early plantings of both the Forrest and Bragg varieties, resulting from earlier adult invasions of these plantings. In 1978, no significant varietal or planting date effects were detected on any nymphal stage. In 1979, however, as in 1977, significantly more nymphs at all stages were collected in the early date plantings, resulting from early invaion of adults.

In the second sampling periods of 1977 and 1978 no significant variety or planting date effects were detected on nymphs. In 1979, significantly more fourth and fifth instar nymphs were collected from early than late plantings, but no differences were detected for second or third instars.

In the third sampling period of 1978, no variety or planting date effects were evident. In 1977 and 1979, populations of fourth and fifth nymphal instars were significantly lower on Forrest than on the later-maturing Bragg or Cobb. This probably occurred because the earlier senescence (maturity) of Forrest results in Bragg and Cobb being more attractive and suitable for oviposition by females. Subsequent nymphal populations therefore were greater in the later maturing varieties.

The very evident difference in results obtained in 1978 compared to 1977 and 1979 probably occurred because of the absence of the early-maturing variety Forrest in the 1978 study.

On September 9, 1977, and October 5, 1979, peaks in fifth nymphal instar occurred in late-planted Bragg which cannot be completely accounted for by subsequent increases in the adult population. This indicates movement of emerging adults into earlier plantings or earlier maturing varieties. The same phenomenon may be occurring with the prolonged fifth instar peak in the late Bragg planting in 1978.

A. hilare Adults

Adults of *A. hilare* were not collected on the first sampling date in 1977 or 1978 from any planting except early-planted Forrest. No variety or planting date effects were detected in either year in the first sampling period. In 1979, significantly more males and females were collected in the early plantings and in the earlier maturing Forrest and Bragg varieties. Although numbers were much smaller, the 1979 result is similar to that observed in *N. viridula,* indicating that *A. hilare* may be potentially controlled with trap crops.

In the second sampling period in 1977, significantly more adults of both sexes were collected in Forrest than Bragg variety. In 1978 no variety or planting date effects were detected. In 1979, significantly more males and females were collected in the early plantings, and Forrest than in Bragg or Cobb varieties.

In the third sampling period of 1977, significantly more males and females were collected from Bragg than from Forrest. In 1978, no significant variety or planting date effects were detected. Again in 1979, significantly fewer adults were collected from Forrest than from the later-maturing varieties. The results observed closely parallel those obtained with *N. viridula*. Apparently the earlier maturity of Forrest resulted in dispersal of adults into later maturing varieties.

As was observed with *N. viridula*, females of *A. hilare* often invaded certain plantings earlier and in larger numbers than males. Likewise, they also often dispersed from a particular planting earlier than males.

N. hilare Nymphs

In the first sampling period of 1977, no significant variety or planting date effects were detected on any nymphal stage because no nymphs were collected from any planting on any of the three sampling dates. In 1978, however, second through fifth nymphal instars were collected on August 23, but only in the early Bragg planting. Only second through fourth instars were found in significantly greater numbers in the early plantings and Bragg variety. The significant variety x planting date interaction occurred by virtue of these stages occurring only in the early Bragg planting. In 1979, all nymphal stages occurred in greater numbers in early date plantings.

In the second sampling period of 1977, significantly more fifth instars were collected in Bragg than Cobb varieties. Interestingly, however, a significant variety x planting date interaction occurred because the late Bragg planting supported more fifth instars than did the early Bragg planting, while the nymphal populations of both Forrest plantings were similar. In 1978, larger numbers of all nymphal stages were collected in early plantings. In 1979, fifth instars were significantly more abundant on Forrest than on later-maturing Bragg and Cobb. Second through fifth instars were more abundant in early plantings.

During the third sampling period of 1977, all nymphal stages were more abundant on Bragg than on Forrest. In 1978, second and third instars only were more abundant in late than early plantings. In 1979, fifth instars only were more abundant on Bragg and Cobb than on Forrest.

E. servus Adults

At beginning of the first sampling periods of 1977 and 1979 on August 15 and July 26, respectively, adults of *E. servus* were collected only from early-planted Forrest. In 1978, a single adult female was collected on the first sampling date from early-planted Cobb. No variety or planting date effects were detected in either 1977 or 1978. In 1979, significantly more males and females were collected from early plantings.

No significant variety or planting date effects were detected in the second sampling period of 1977. In 1978, however, significantly larger populations of both males and females were collected from early date plantings. In 1979, on the other hand, significantly more adults were collected from Forrest than from the later-maturing varieties of Bragg and Cobb.

No significant variety or planting effects were detected in the third sampling period of 1977. In 1978, however, significantly more adults were collected from late-date plantings and from Cobb than from Bragg. In 1979, as Forrest plantings matured, adults dispersed to Bragg and Cobb which were still acceptable hosts.

E. servus Nymphs

No nymphs of any stage were collected in the first sampling period of either 1977 or 1978. In 1979, second through fifth nymphal instars were collected from both Forrest plantings and from early plantings of both Bragg and Cobb. Only fourth and fifth nymphal instars were significantly more abundant in the early plantings.

In the second sampling period of 1977, second and fourth nymphal instars were more abundant in early-date plantings and on Forrest variety, while the reverse was true with third instars. The reason for this inconsistent result is unknown. In 1978, third, fourth and fifth nymphal instars were significantly more abundant in early plantings, which corresponds with the availability of developing pods as food. Likewise, in 1979, second and third instars were significantly more abundant in early plantings.

In the third sampling period of 1977, second and third nymphal instars were more abundant in early plantings, and second, third and fourth instars were more abundant on Bragg than on Forrest. In 1978, nymphal stages were more numerous in late plantings, and fourth and fifth instars more numerous on Cobb than Bragg. In 1979, fourth and fifth instars were more abundant on Bragg and Cobb than on Forrest.

Conclusions

N. viridula was the most abundant species on all planting dates in all three years. Characteristically, *N. viridula, A. hilare,* and *E. servus* adults colonized early plantings of early maturing varieties first and in greatest numbers. As the season progressed, later plantings and later-maturing varieties became more attractive to all species and in late season these plantings supported the largest populations of both adults and nymphs. As early-maturing varieties senesced, adults of all species studied moved to varieties of later maturity.

Results indicate that the trap cropping method of controlling *N. viridula* developed in Louisiana (Newsom and Herzog, 1977) may also be used against this species in Florida.

CHAPTER IV

POPULATION DYNAMICS OF STINKBUG COMPLEX ON SOYBEANS

Results

Three species of stinkbugs, besides others of minor importance, were sampled weekly by both ground cloth and sweep net methods on three different soybean varieties in Florida in 1977, 1978, and 1979.

Nezara viridula Adults

Populations of *N. viridula* adults sampled from early and late planting dates of Forrest and Bragg varieties in 1977, Bragg and Cobb in 1978, and Forrest, Bragg, and Cobb in 1979 are shown Figs. 1 through 14, respectively. Results of statistical analyses are shown in Table 4.

Highly significant differences ($P<0.01$) in populations of both males and females through time were observed for all three periods of 1977. Planting date x week interactions were highly significant ($P<0.01$) for both sexes in the second sampling period, and significant ($P<0.05$) for females but nonsignificant ($P>0.05$) for males during the third sampling period of 1977.

Variety x week interactions were not significant ($P>0.05$) for either males or females in the first and second sampling periods, but were highly significant ($P<0.01$) in the third period. No significant

(P>0.05) planting date x variety x week interactions occurred in 1977.

Populations of both sexes differed (P<0.01) through time in all three sampling periods of 1978. Planting date x week interactions were significant (P<0.05) for females and highly significant (P<0.01) for males in the first sampling period, but were nonsignificant (P>0.05) in the second and third sampling periods. No significant (P>0.05) variety x week interactions occurred in the first, second and third sampling periods. No significant (P>0.05) planting date x week x variety interactions occurred in 1978.

The week effect was significant (P<0.01) for males and females in the first, second, and third sampling periods of 1979. Planting date x week interactions were significant (P<0.05) for females but nonsignificant (P>0.05) for males in the first sampling period; however, these interactions were highly significant for both sexes in the second and third sampling periods. No significant variety x week interactions were observed for males or females in the first sampling period, but they were highly significant (P<0.01) for females in the second and third sampling periods. For males, this interaction was nonsignificant (P>0.05) in the second, but highly significant (P<0.01) in the third periods. No significant (P>0.05) planting date x variety x week interactions were detected.

N. viridula Nymphs

Populations of *N. viridula* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 15 through 28. Results of statistical analyses are shown in Table 4.

Table 4. Results of analyses of variance for *N. viridula* concerning week effects, planting date x week effects, planting date x week, variety x week, and planting date x variety x week interactions.

Year	Period	First				Second				Third			
1977	Date	8/5 to 8/20				8/26 to 9/24				10/1 to 10/27			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	**	NS	NS	**	NS	NS	NS	**	*	**	NS
	Male	**	**	NS	NS	**	NS	NS	NS	**	NS	**	NS
	Fifth	NS	NS	NS	NS	**	NS	NS	NS	**	NS	**	NS
	Fourth	**	**	NS	NS	**	NS	NS	NS	**	*	**	NS
	Third	**	**	NS	NS	**	*	NS	NS	**	NS	NS	NS
	Second	**	**	NS	NS	*	*	NS	NS	**	NS	NS	NS
1978	Date	7/26 to 8/23				8/29 to 9/26				10/3 to 11/1			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	*	NS	NS	**	NS	NS	NS	**	NS	NS	NS
	Male	**	**	NS	NS	**	NS	NS	NS	**	NS	NS	NS
	Fifth	**	NS	NS	NS	*	*	**	**	*	NS	NS	NS
	Fourth	**	**	NS	NS	**	NS	NS	NS	**	NS	NS	NS
	Third	**	**	NS	NS	**	NS	NS	NS	**	NS	NS	NS
	Second	**	**	NS	NS	**	*	NS	NS	**	*	NS	NS

Table 4. Continued

Year	Period	First				Second				Third			
1979	Date	7/26 to 8/21				8/28 to 9/29				10/5 to 11/1			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	*	NS	NS	**	**	**	NS	**	NS	**	NS
	Male	**	NS	NS	NS	**	**	NS	NS	**	NS	**	NS
	Fifth	**	**	**	NS	**	NS	NS	NS	**	NS	**	NS
	Fourth	**	**	*	NS	**	*	NS	NS	**	NS	**	NS
	Third	**	**	*	NS	**	*	NS	NS	**	NS	NS	NS
	Second	**	**	*	NS	**	*	NS	NS	**	NS	NS	NS

NS = Non-significant ($P > 0.05$)

* = Significant ($P \leq 0.05$)

** = Highly significant ($P < 0.01$)

In 1977, highly significant differences ($P<0.01$) were detected in nymphal populations (except the fifth instar, $P>0.05$) among weeks during the first sampling period. In the second and third sampling periods nymphal populations differed significantly ($P<0.01$) among weeks, except the second instar in the second sampling ($P<0.05$). Highly significant ($P<0.01$) planting date x week interactions occurred in the first sampling period, but were nonsignificant ($P>0.05$) for the fifth instar. In the second sampling period, these interactions were significant ($P<0.05$) for the second and third instars and nonsignificant ($P>0.05$) for the fourth and fifth instars. In the third sampling period populations this interaction was nonsignificant ($P>0.05$) for all nymphal stages (except the fourth instar, $P<0.05$).

In 1978, significant differences ($P<0.01$) were detected for all nymphal stages among weeks in the first sampling period. In the second and third sampling periods, this interaction was significant for ($P<0.01$) second, third, fourth and fifth ($P<0.05$) instars. No significant ($P>0.05$) planting date x week interactions was found for the fifth instar in the first sampling period; however this interaction was highly significant ($P<0.01$) for all other stages. In the second sampling period no significant ($P>0.05$) planting date x week interactions occurred for the third and fourth instars, but this interaction was significant ($P<0.05$) for the second and fifth instars. In the third sampling period that interaction was significant ($P<0.05$) only for the second instar. No significant ($P>0.05$) planting date x week or planting date x week x variety interactions were detected.

In 1979, nymphal populations differed significantly ($P<0.01$) among weeks in the first, second, and third sampling periods. Planting date x week interactions were highly significant ($P<0.01$) for all nymphal stages in the first sampling period. In the second sampling period these interactions were significant ($P<0.05$) for second, third and fourth instars, but nonsignificant ($P>0.05$) for the fifth instar. No significant ($P>0.05$) planting date x week interaction occurred in the third sampling period. In the first sampling period, significant variety x week interactions occurred for second, third, fourth ($P<0.05$) and fifth ($P<0.01$) instars; however, this interaction was nonsignificant ($P>0.05$) for all nymphal stages in the second sampling period. In the third sampling period, this interaction was highly significant ($P<0.01$) for the fourth and fifth, but nonsignificant ($P>0.05$) for the second and third instars. No significant ($P>0.05$) planting date x variety x week interactions occurred in any sampling period.

A. hilare Adults

Populations of *A. hilare* adults sampled from early and late planting dates of Forrest and Bragg varieties in 1977, Bragg and Cobb in 1978, and Forrest, Bragg and Cobb in 1979 are shown in Figs. 29 through 42, respectively. Results of statistical analyses are shown in Table 5.

In 1977, populations of both males and females differed significantly ($P<0.01$) among weeks in the first, second, and third sampling periods. Planting date x week interactions were nonsignificant ($P>0.05$) for males and females in the first and third sampling periods, but were

Table 5. Results of analyses of variance for *A. hilare* concerning week effects, planting date x week effects, planting date x week, variety x week, and planting date x variety x week interactions.

Year	Period	First				Second				Third			
1977	Date	8/5 to 8/20				8/26 to 9/24				10/1 to 10/27			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	NS	NS	NS	**	**	*	**	**	NS	**	NS
	Male	**	NS	NS	NS	**	**	**	**	**	NS	**	NS
	Fifth	NS	NS	NS	NS	**	*	NS	NS	**	NS	**	NS
	Fourth	NS	NS	NS	NS	**	NS	**	NS	**	NS	**	NS
	Third	NS	NS	NS	NS	**	**	**	NS	**	NS	*	NS
	Second	NS	NS	NS	NS	**	**	NS	NS	**	NS	*	NS
1978	Date	7/26 to 8/23				8/29 to 9/26				10/3 to 11/1			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	NS	**	NS	**	NS	NS	NS	**	*	NS	NS
	Male	**	NS	NS	NS	**	NS	NS	NS	**	**	NS	NS
	Fifth	NS	NS	NS	NS	**	NS	NS	NS	**	**	NS	NS
	Fourth	**	**	**	**	**	NS	NS	NS	**	**	NS	NS
	Third	**	**	**	**	**	**	**	**	**	**	NS	NS
	Second	**	**	**	**	**	**	**	**	**	**	NS	NS

Table 5. Continued

Year	Period	First				Second				Third			
1979	Date	7/26 to 8/21				8/28 to 9/29				10/5 to 11/1			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	**	**	NS	**	**	*	NS	**	*	*	NS
	Male	**	**	NS	NS	**	NS	NS	NS	**	**	NS	NS
	Fifth	**	**	*	NS	**	NS	NS	NS	**	**	*	NS
	Fourth	**	**	*	NS	**	NS	NS	NS	**	*	*	NS
	Third	**	**	NS	NS	**	NS	NS	NS	**	*	NS	NS
	Second	**	**	NS	NS	**	**	NS	NS	**	NS	NS	NS

NS = Non-significant ($P > 0.05$)

* = Significant ($P < 0.05$)

** = Highly significant ($P < 0.01$)

highly significant (P<0.01) in the second. Variety x week interactions were nonsignificant (P>0.05) for both males and females in the first sampling period; they were significant (P<0.05 and P<0.01 for males and females, respectively) in the second, and highly significant (P<0.01) for both in the third. No significant planting date x variety x week interactions occurred in any sampling period.

In 1978, the two sexes differed significantly (P<0.01) among weeks in the first, second, and third sampling period. No significant (P>0105) planting date x week interactions occurred in the first or second sampling periods, but this interaction was significant (P<0.05) for females and highly significant (P<0.01) for males in the third. Variety x week interactions were highly significant (P<0.01) for females and nonsignificant (P>0.05) for males in the first sampling period, but were nonsignificant (P>0.05) for both in the second and third periods. No significant (P>0.05) planting date x week x variety interations occurred.

In 1979, both sexes differed significantly (P<0.01) among weeks in the first, second, and third sampling periods. Planting date x week interactions were highly significant (P<0.01) for both sexes in the first sampling period, were highly significant (P<0.01) for females and nonsignificant (P>0.05) for males in the second, and significant (P<0.05) for females and highly significant (P<0.01) for males in the third. Variety x week interactions were highly significant (P<0.01) for females in the first sampling period, but significant (P<0.05) in the second and third. This interaction was nonsignificant (P>0.05) for males throughout the season. No significant (P>0.05) planting date x week x variety interactions occured.

A. hilare Nymphs

Populations of *A hilare* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 43 through 56. Results of statistical analyses are shown in Table 5.

In 1977, no significant differences ($P>0.05$) were detected in nymphal populations among weeks during the first sampling period, but differences ($P<0.01$) were observed for all nymphal stages in the second and third periods. Planting x week interactions were not significant ($P>0.05$) for all stages in the first and third sampling periods, but were highly significant ($P<0.01$) for second and third, nonsignificant ($P>0.05$) for fourth, and significant ($P<0.05$) for fifth nymphal instars. Variety x week interactions were nonsignificant ($P>0.05$) for all nymphal stages in the first sampling period, nonsignificant ($P>0.05$) for second and fifth instars but highly significant ($P<0.01$) for third and fourth in the second, and significant ($P<0.05$) for second and third, and highly significant ($P<0.01$) for fourth and fifth in the third sampling period. No significant ($P>0.05$) planting date x week x variety interactions occurred.

In 1978, week effects observed were significant ($P<0.01$) for second, third, and fourth instars but nonsignificant ($P>0.05$) for fifth instars in the first sampling period. The week effect was highly significant ($P<0.01$) for all nymphal stages in the second and third sampling periods. Planting date x week interactions were highly significant ($P<0.01$) for second, third, and fourth instars, nonsignificant ($P>0.05$) for fifth instars in the first sampling period, but highly significant ($P<0.01$) for all nymphal stages in the third.

Variety x week interactions were highly significant ($P<0.01$) for second, third, and fourth instars, but nonsignificant ($P>0.05$) for fifth instars in the first sampling period, highly significant ($P<0.01$) for second and third but nonsignificant ($P>0.05$) for fourth and fifth instars in the second, and nonsignificant ($P>0.05$) for all nymphal stages in the third. Planting date x week x variety interactions were highly significant ($P<0.01$) for the second, third, and fourth instars, but nonsignificant ($P>0.05$) for the fifth in the first sampling period. In the second period these interactions were highly significant ($P<0.01$) for the second and third instars, but nonsignificant ($P>0.05$) for the fourth and fifth instars, and in the third sampling period the three-factor interactions were nonsignificant ($P>0.05$) for all nymphal stages.

In 1979, highly significant ($P<0.01$) week effects were observed for all nymphal stages in the first, second and third sampling periods. Planting date x week interactions were highly significant ($P<0.01$) for all stages in the first sampling period, but were nonsignificant ($P>0.05$), except for second instar ($P<0.01$) in the second, and were nonsignificant ($P<0.05$) for the second, significant ($P<0.05$) for third and fourth, and highly significant ($P<0.01$) for fifth instars in the third sampling period. Variety x week interactions were significant ($P<0.05$) for fourth and fifth instars but nonsignificant ($P>0.05$) for second and third in the first sampling period, but no significant interaction ($P>0.05$ was found for any stages in the second period. In the third sampling period, this interaction was significant ($P<0.05$) for fourth and fifth instars but nonsignificant ($P>0.05$) for second and third stage nymphs in the third sampling period. No significant ($P>0.05$) planting date x week x variety were observed for any nymphal stage in 1979.

E. servus Adults

Populations of *E. servus* adults sampled in 1977, 1978 and 1979 are shown in Figs. 57 through 70. Results of statistical analyses are shown in Table 6.

In 1977 no significant differences ($P>0.05$) were detected in male populations among weeks, but female populations differed significantly ($P<0.05$) through time in the first sampling period. Week effects were highly significant ($P<0.05$) for both sexes in the second and third periods. No significant ($P>0.05$) planting date x week interactions occurred in any sampling period. Variety x week interactions were not significant ($P>0.05$) for the two sexes in the first and second sampling periods, but were highly significant ($P<0.01$) for males and nonsignificant ($P>0.05$) for females in the third. No significant ($P>0.05$) planting date x week x variety interactions occurred.

In 1978, week effects were highly significant ($P<0.01$) for both sexes in the first, second, and third sampling periods. No significant ($P>0.05$) planting date x week interactions were detected for either sex in the first and second sampling periods, but these interactions were highly significant ($P<0.01$) for both sexes in the third. Variety x week interactions were nonsignificant ($P>0.05$) for both sexes in the first and second sampling periods, but were significant ($P<0.05$) in the third. No significant ($P>0.05$) planting date x week x variety interactions occurred.

Table 6. Results of analyses of variance for *E. servus* concerning week effects, planting date x week effects, planting date x week, variety x week, and planting date x variety x week interactions.

Year	Period	First				Second				Third			
1977	Date	8/5 to 8/20				8/26 to 9/24				10/1 to 10/27			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	*	NS	NS	NS	**	NS	NS	NS	**	NS	NS	NS
	Male	NS	NS	NS	NS	**	NS	NS	NS	**	NS	**	NS
	Fifth	NS	NS	NS	NS	**	**	NS	NS	**	NS	*	NS
	Fourth	NS	NS	NS	NS	**	*	**	NS	**	NS	**	NS
	Third	NS	NS	NS	NS	**	**	NS	NS	**	**	**	NS
	Second	NS	NS	NS	NS	**	**	NS	NS	**	**	**	NS
1978	Date	7/26 to 8/23				8/29 to 9/26				10/3 to 11/1			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	NS	NS	NS	**	NS	NS	NS	**	**	*	NS
	Male	**	NS	NS	NS	**	NS	NS	NS	**	**	*	NS
	Fifth	NS	NS	NS	NS	**	NS	NS	NS	**	**	NS	NS
	Fourth	NS	NS	NS	NS	**	NS	NS	NS	**	**	NS	NS
	Third	NS	NS	NS	NS	**	**	NS	NS	**	**	NS	
	Second	NS	NS	NS	NS	**	**	NS	NS	**	**	**	NS

Table 6. Continued

Year	Period	First				Second				Third			
1979	Date	7/26 to 8/21				8/28 to 9/29				10/5 to 11/1			
	Stage	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW	Wk	PdxWk	VtyxWk	PxVxW
	Female	**	**	NS	NS	**	NS	NS	NS	**	**	**	**
	Male	**	**	NS	NS	**	NS	NS	NS	**	**	**	*
	Fifth	*	**	NS	NS	**	NS	NS	NS	**	*	NS	NS
	Fourth	**	**	NS	NS	**	NS	NS	NS	**	NS	NS	NS
	Third	**	*	NS	NS	**	*	NS	NS	**	**	**	NS
	Second	**	*	NS	NS	**	*	NS	NS	**	**	**	NS

NS = Non-significant ($P > 0.05$)

* = Significant ($P < 0.05$)

** = Highly significant ($P < 0.01$)

In 1979, week effects were highly significant ($P<0.01$) for both sexes in the first, second, and third sampling periods. No significant ($P>0.05$) planting date x week interactions were detected for either sex in the first and second sampling periods, but these interactions were highly significant ($P<0.01$) for both sexes in the third. Variety x week interactions were nonsignificant ($P>0.05$) for both sexes in the first and second sampling periods, but were highly significant ($P<0.01$) in the third. No significant ($P>0.05$) planting date x week x variety interactions occurred in the first and second sampling period, but were highly significant ($P<0.01$) for females and significant ($P<0.05$) for males in the third period.

E. servus Nymphs

Populations of *E. servus* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 71 through 84. Results of statistical analyses are shown in Table 6.

In 1977, no significant differences ($P>0.05$) were found in nymphal populations among weeks in the first sampling perid. The week effect was highly significant ($P<0.01$) for all nymphal stages in the second and third periods. Planting date x week interactions were nonsignificant ($P>0.05$) for all nymphal stages in the first sampling period, but were significant ($P<0.05$) for fourth instar and highly significant ($P<0.01$) for second, third, and fifth instars in the second, and nonsignificant ($P>0.05$) for fourth, and fifth instars and highly significant ($P<0.01$) for second and third in the third period. Variety x week interactions were not significant ($P>0.05$) for nymphal populations in the first sampling period, but were highly significant (P<0.01) for fourth instar and nonsignificant (P>0.05) for the other nymphal stages in the second, and significant (P<0.05) for fifth and highly significant (P<0.01) for second, third, and fourth instars in the third sampling period.

In 1978, no significant (P>0.05) week effects were observed for nymphal populations in the first sampling period; however, populations of all nymphal stages varied significantly (P<0.01) through time in the second and third. Planting date x week interactions were not significant (P>0.05) for any nymphal stages in the first sampling period, but were highly significant (P<0.01) for second and third and nonsignificant for fourth and fifth instars in the second, and highly significant (P<0.01) for all stages in the third. Variety x week interactions were nonsignificant (P>0.05) in nymphal populations in the first and second sampling periods, but were highly significant (P<0.01) in the second and third and nonsignificant (P>0.05) in the fourth and fifth instars in the third. No significant differences (P>0.05) were detected in nymphal populations among planting date x week x variety interactions in the first, second, and third sampling periods.

In 1979, week effects were highly significant (P<0.01) for second, third, and fourth instars, and significant (P<0.05) for fifth instars in the first sampling period, but highly significant (P<0.01) for all stages in the second and third periods. Planting date x week interactions were significant (P<0.05) for second and third instars, and highly significant (P<0.01) for fourth and fifth in the first sampling period, nonsignificant (P>0.05) for fourth and fifth instars, and significant (P<0.05) for second and third in the second period, but nonsignificant (P>0.05) for fourth instar, significant (P<0.05) for fifth, and highly significant (P<0.01) for second and third in the third sampling period. Variety x week interactions were nonsignificant (P>0.05) in nymphal populations during the first and second sampling periods, but were highly significant (P<0.01) for second and third but nonsignificant (P>0.05) for fourth and fifth instars in the third. No significant (P>0.05) planting date x week x variety interactions were detected for any nymphal stage in any sampling period.

Discussion

Populations of *N. viridula, A. hilare* and *E. servus* were very low in 1977, increased somewhat in 1978 and were very high in 1979 on three soybean varieties in this study. The relatively cold winter season of 1976-77 probably contributed to low stinkbug populations in 1977.

No insecticide was used for stinkbug control in the experimental plots surveyed in 1977, 1978 and 1979.

In the following discussion emphasis will be given to adult populations as the stage in the life cycle capable of dispersal among soybean plantings and as such governs the timing and magnitude of nymphal populations in a particular planting. Discussions of nymphal populations will deal primarily with second and fifth stage nymphs as they relate to adult populations.

N. viridula Adults

Southern green stinkbug adults colonized early-planted Forrest and Bragg during the first sampling period (8/5 to 8/20) of 1977. Seasonal abundance of this species increased through time (week) and the significant interaction planting date with week indicates that adult populations increased more rapidly in early than in late plantings. During the second sampling period (8/26 to 9/24), population trends were similar in the two planting dates. Adult populations increased sharply during this period on early-planted Forrest, showing a strong preference for the early-planted, early-maturing variety. Adult populations increased on early-planted Bragg from August 20 to September 9, however, populations on late-planted Bragg became higher thereafter through September 24. Males and females were low on late-planted Forrest from August 26 to September 9, but the female population increased substantially thereafter, reached a peak on October 1, then decreased sharply. Meanwhile, male population behavior was quite different on this variety because populations increased from August 26 to October 8 at which time the peak occurred.

Males and females increased sharply on the late planting date Bragg by September 24, reached their peak populations on October 15, and thereafter declined rapidly. By the end of the season (October 27) adult populations had declined to zero on both early and late planting date Forrest because these plantings had senesced; but a small number of adults still remained on early and late planting date Bragg at this time.

It is important to note that the interaction of planting date with week was a significant factor during the first period (8/5 to 8/20) and during the third period (10/1 to 10/27), and that the interaction of variety with week was also significant by the end of the season (10/1 to 10/27). This emphasizes the ability of the adults to find plantings which furnish adequate food in the form of pods. After developing through one generation, adults then prefer the later-maturing varieties.

Adults first colonized both early-planted Bragg and early-planted Cobb during the first period (7/26 to 8/23) of 1978 and increased most rapidly there during the second sampling period (8/29 to 9/26). Males and females reached their peak population levels on early-planted Bragg on October 3, but by that time populations were similar on early and late plantings of Cobb.

Colonization of late-planted Bragg and Cobb proceeded at a low rate from August 23 to September 11, but from September 21 to October 10, populations of both sexes were higher on the Cobb planting. Peak populations occurred in both plantings on October 10, and then declined more rapidly in Bragg than Cobb as that variety matured.

Adult populations increased rapidly on early planting date Cobb, reaching a peak on October 17, declining thereafter, while populations on Cobb peaked on October 10.

Once more, it is important to note that the interaction of planting date x week was significant during the first sampling period (7/26 to (8/23).

Males and females colonized on early planted Forrest in 1979 in a manner similar to that observed in 1977. Both sexes were significantly higher on this than on other plantings from August 21 to September 29, reaching a peak at this time. Numbers declined rapidly thereafter to zero on October 191. Although delayed by about three weeks, adult populations increase in early-planted Bragg was similar to that in early-planted Forrest, peak populations occurring on October 26. Few adults were collected from Cobb through September 29, but increased rapidly thereafter to a peak on October 26. As populations declined on early-planted Forrest, corresponding increases occurred on the early Bragg and Cobb plantings.

Adult populations remained very low on late-planted Forrest throughout the 1979 sampling season. The "attractive" stages of this planting were apparently asynchronous with adult populations and thereby escaped infestation.

Adults began to colonize late-planted Bragg by September 10 and increased slowly through September 29. Numbers then increased rapidly to a peak on October 29, declining rapidly the following week. Adult populations remained very low on late-planted Cobb through September 29. Thereafter population increase was very rapid, peaking October 29 and declining to November 1.

N. viridula Nymphs

No nymphal populations were detected before August 20 and 31 of 1977 in early and late plantings, respectively, approximately one week after females were first collected in each planting. In early and late plantings of Forrest it is possible to detect distinct peak populations of second nymphal instars, occurring on August 31 and September 9, respectively. Second nymphal instar population peaks are not evident on either

Bragg planting, indicating a more continuous influx of adults (females) as the season progressed. Nymphal development produced peak fifth nymphal instar populations on September 24, October 1, 8, and 15 in early- and late-planted Forrest and Bragg, respectively. These peaks corresponded exactly to peak adult populations in the same plantings. The peaks occur at one-week intervals which closely correspond to the timing of plant reproductive events (pod set and pod fill) in the respective plantings.

Nymphal collections in 1978 were first made from early plantings of Bragg and Cobb on August 23 and on September 5 and 11 from late plantings of Cobb and Bragg, respectively. Unlike 1977, no distinct peaks of second nymphal instars could be detected in the earlier plantings. This indicates a more or less continuous influx of adults into the early plantings from surrounding soybeans outside the experimental area (which included Forrest and other varieties of similar maturity). In the later plantings of both Bragg and Cobb, however, more or less distinct peaks occurred, indicating a more synchronous influx of adults. Maximum numbers of fifth instars occurred on September 21-26, October 3-10, and October 3 in early- and late-planted Bragg and late-planted Cobb, respectively. An indistinct peak occurred in early-planted Cobb, from September 21 through October 17. Peak fifth instar populations in most cases preceded those of adults by one week.

In 1979, nymphal populations were first detected on August 1, 7, 15, 21, and September 4, on early Forrest and Bragg, late Forrest, early Cobb, and late Bragg and Cobb, respectively. Because of the extremely large poulation occurring in 1979, it is, in most cases, impossible to detect distinct first or subsequent generation peaks of second instars. Peak numbers of fifth instars occurred on October 5 (early and late Forrest), October 19 (early Bragg and early and late Cobb) and bimodal peaks on October 5 and 19 (late Bragg).

A. hilare Adults

Throughout the three-year study period adult populations of *A. hilare* remained very low, consistent with the results obtained by McPherson et al. (1979) in Louisiana. In 1977, adults colonized Forrest variety more rapidly than Bragg, indicating that this species responds to the availability of developing pods in a manner similar to *N. viridula.*

On early-planted Forrest, numbers increased sharply from August 5 to a peak on September 9, then declined before rising to a secondary peak on October 1. On late Forrest, population increase was delayed by approximately two weeks; with maximum numbers collected October 1. Thereafter populations declined on both Forrest plantings, disappearing completely by October 22 as the crop senesced. On the Bragg variety adults increased more gradually through the first and second sampling periods, reaching peak populations on both early and late plantings on October 8, and then declining sharply to the end of the season (10/27).

While populations remained low in 1978, initial colonizers were more numerous than was the case in 1977. Although the shape of the population curves appears somewhat different, little numerical difference is evident among populations on early or late plantings of Bragg or Cobb. On early-planted Bragg the maximum number of adults was collected on October 3, declining to negligible levels by the following week. The peak of adult males on early-planted Cobb occurred on October 3, females on October 10 and on late-planted Cobb the peak occurred on October 24. The late Bragg population displayed bimodal peaks (9/26 and 10/17) analogous to that occurring on early Forrest in 1977. After October 3 it was evident that adults preferred the later plantings of Bragg and Cobb.

During the first sampling period of 1979 (through 8/21) adults colonized only early Forrest and Bragg, negligible numbers being collected in other plantings. Population increase was rapid in the second sampling period in all plantings except late Bragg and Cobb, and peak numbers of adults were collected from the two Forrest plantings by the end of this period (9/29). Populations declined on early and late Forrest plantings during the third sampling period as the crop began to senesce. Meanwhile, maximum numbers were collected in the two Bragg plantings on October 5, and in early and late Cobb on October 12 and 19, respectively, after which time numbers declined to the end of the season.

A. hilare Nymphs

In 1977, no nymphs of *A. hilare* were collected during the first sampling period. By August 26, second instars were present in early plantings of both Forrest and Bragg, being more abundant on Forrest. On August 31, this stage was also collected from late plantings of the two varieties. The timing of occurrence of second-stage nymphs, indicative of oviposition timing, supports results obtained showing that adults first colonize early plantings. Peak populations of fifth stage nymphs occurred in both Forrest plantings on October 1 and on both Bragg plantings on October 8. Timing and shape of the population curves for second and fifth stage nymphs indicated that but a single generation occurred in soybean within this study in 1977.

Second nymphal instars were collected during the first sampling period of 1978 only on early-planted Bragg (8/23), the peak abundance occurring August 23-29. On early Cobb, first detection and peak abundance occurred simultaneously on August 29. Second stage nymphs were first collected from late Bragg and Cobb on September 5, and population peaks occurred one and two weeks later, respectively. On late Bragg a secondary peak occurred on October 3. Maximum numbers of fifth stage nymphs occurred on early Bragg and Cobb on October 3, and on late Bragg and Cobb on October 17 and 24, respectively. Timing of peak abundance of second instars on early Bragg and the secondary peak on late Bragg (six weeks lag time) indicates the possibility that two generations may have occurred during the 1978 season, but probably not in the same planting.

Nymphs of *A. hilare* were detected much earlier in the 1979 season than was the case in either 1977 or 1978. Second instars were first detected in the respective early and late plantings of Forrest, Bragg, and Cobb as follows: August 1, 7, 21, September 4, August 21, and September 4. On early Forrest populations peaked on August 21 with a second, larger peak occurring on September 29, while a single peak occurred on the late planting on September 5. On early Bragg an initial peak occurred on August 21 with a secondary on October 5, while peaks occurred on September 21 and October 5 on the later planting. Early Cobb supported peak populations on September 4 and September 29; the later planting displayed no distinct peak, populations remaining more or less stable from September 10 through October 19. Maximum numbers of fifth instars were collected from the respective early and late plantings of Forrest, Bragg and Cobb on September 21, 29, October 12, 19, 12, and 19. The timing of initial and secondary peaks of second instar abundance on early plantings of Forrest and Bragg indicate that two generations may have occurred in these plantings. However, timing of the peaks in early Cobb and late Forrest, Bragg and Cobb indicate that the secondary peaks probably originated from dispersal of first field generation females into these plantings from early Forrest and Bragg.

In most cases population trends, if not magnitudes, were similar for *A. hilare* among plantings to those observed with *N. viridula.* Early plantings supported larger nymphal populations than did the later plantings, while the opposite was usually true of *N. viridula.*

E. servus Adults

E. servus adults were not abundant in any of the three years of this study, consistent with the results obtained by McPherson et al. (1979). Both males and females of this species colonized all plantings in low numbers during the first sampling period of 1977. During the second and third sampling periods, while the form of the population curves appears somewhat different among plantings, numerically there is little difference. Peak populations occurred in early- and late-planted Forrest on October 1, in early Bragg on October 8, and in late Bragg on October 1-8.

During the 1978 season, small numbers of adults colonized plantings of Cobb one to two weeks earlier than Bragg. This was an unusual situation which occurred only with this species and only in this year. In the second sampling period, populations on early Bragg peaked rapidly (although small numbers were present) on September 5, and produced a secondary peak on September 26. In early Cobb the peak was delayed until September 21-26. It was not until near the end of the third sampling period that peak populations occurred in late Bragg and Cobb, on October 17 and 24, respectively. .

In 1979, first colonizing adults were collected on August 1 in early plantings of Forrest and Bragg. By the end of the first sampling period on August 21, plantings ranked according to adult abundance as follows: early Forrest, Bragg and Cobb, and late Forrest, Bragg and Cobb. Numerical abundance increased sharply during the second sampling period in all plantings except early Cobb. Peak adult populations occurred on respective early and late plantings of Forrest, Bragg and Cobb as follows: October 5, September 29, October 12, 12, 12, and 19. On both Forrest plantings, populations declined as the crop senesced to zero by October 19, while active adult populations were still present in the remainder of the plantings when sampling was discontinued after November 1.

E. servus Nymphs

Like the adults of this species, nymphal populations were very low during the 1977 cropping season. No nymphal populations were detected during the first sampling period, but second instars were collected from early Forrest and Bragg on August 26, and on the late plantings on August 31. Second stage nymphs peaked rapidly and sharply in early-planted Forrest and late-planted Forrest and Bragg on August 31, September 9, and August 31. On early Bragg no distinct population peak occurred, and numbers remained relatively constant from August 26 through September 16, then declined slowly to the end of the season.

Fifth nymphal instars produced distinct peaks in early- and late-planted Forrest on October 1 and September 16, respectively. Populations of this developmental stage fluctuated more widely through time on Bragg, reaching maximum numbers on October 1 and 8 in late and early plantings, respectively. This species apparently produced but a single generation on soybean during the 1977 cropping season.

As was the case in 1977, no *E. servus* nymphs were collected in the first sampling period of 1978. First second nymphal instars were collected from early plantings on August 29 and from late plantings of Cobb and Bragg on September 5 and 11, respectively. Peak populations occurred on early Bragg and Cobb and late Bragg on October 5, August 29, and September 11, respectively. Second instars produced no distinct population peak in late-planted Cobb, but remained relatively constant from September 5 through October 17. Fifth instars produced distinct single peaks only in late-planted Bragg on October 10. In early Bragg initial and secondary peaks occurred on September 11 and 26. In early Cobb, maximum numbers were collected on September 26. In early Cobb, maximum numbers were collected on September 26, preceded by a preliminary smaller peak on September 5. The situation on late-planted Cobb was very different. Fifth stage nymphs increased sharply from August 29 to September 21, then continued to increase gradually through October 24 before declining to the termination of the study on November 1. Only a single generation was apparent during 1978.

Nymphal populations were much larger in 1979 than either the 1977 or 1978 studies, as well as occurring earlier in the season. Single peaks of second instar populations were produced only in late plantings of Forrest and Cobb, both occurring on September 10. Double peaks occurred in early Forrest (August 21 and September 21-29), early Cobb (September 4 and 29), and late Bragg (September 21 and October 12). Early-planted Forrest apparently produced three population peaks, on August 21, September 10, and October 5. Maximum abundance of fifth nymphal instars occurred in respective early and late plantings of Forrest and Cobb on September 21-29, September 10-21, October 12, and 5, respectively. Only in Bragg did apparent bimodal peaks occur, September 4 and October 12, in the early planting and September 19 and October 19 in the late planting. It is apparent that *E. Servus* produced two nymphal generations within the early Forrest and Bragg plantings.

Piezodorus guildinii

Jones (1979) was the first to report this species from soybean in the United States. He indicated that this important South American pest was able to withstand the cold winters of South Carolina. In 1977, a single female of this species was collected at Quincy within the experimental area of this study. In 1978 several additional specimens were collected. By the 1979 cropping season populations had increased substantially, and 219 adults and 164 nymphs were collected in the course of the sampling season. Subsequently, in 1980 this species was again collected at Quincy and in Madison Co. (D. C. Herzog, personal communication)[*] and in several Georgia counties adjoining Florida (J. W. Todd, personal communication).[**]

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This species is rapidly increasing in abundance. This situation should be watched closely as a similar situation in Brazil resulted in the almost complete displacement of *N. viridula* by *P. guildinii*.

Conclusions

Adults of *N. viridula* were usually the first to colonize timed plantings of Forrest, Bragg and Cobb during the three years of this study. Left uncontrolled this species produced very large nymphal and subsequent generation adult populations. Because of the magnitude of populations and apparent overlap, the number of generations produced in individual plantings was impossible to determine, but it is probable that two occurred in certain plantings.

Adults of both *A. hilare* and *E. servus* were very low relative to *N. viridula*. Nymphal populations of these species likewise were low with the exception of 1979. The dynamics of populations of these two species on the times varietal plantings appeared to be quite similar to that of *N. viridula*. Single nymphal generations were produced in 1977 and 1978, but two generations of each species occurred in some plantings in 1979.

In Florida, *A. hilare* and *E. servus* pose little threat to soybean production themselves, but as species components of the stinkbug pest complex they become significant because damage produced by members of the complex is similar (McPherson 1978) and additive.

CHAPTER V

COMPARISON OF TWO RELATIVE SAMPLING METHODS FOR THE STINKBUG COMPLEX AND SOYBEAN

Results

Populations of *N. viridula* adults sampled by ground cloth method from early and late planting dates of Forrest and Bragg varieties in 1977, Bragg and Cobb in 1978, and Forrest, Bragg and Cobb in 1979 are shown in Figs. 1 through 14, respectively. Populations of *N. viridula* nymphs sampled in 1977, 1978, and 1979 are shown in Figs. 15 through 28. Results of statistical analyses are shown in Tables 7 through 13.

Populations of *A. hilare* adults sampled by ground cloth method in 1977, 1978, and 1979 are shown in Figs. 29 through 42; and nymphal populations sampled in those years, are shown in Figs. 43 through 56. Results of statistical analyses are shown in Tables 7 through 13.

Populations of *E. servus* adults sampled by ground cloth method in 1977, 1978, and 1979 are shown in Figs. 57 through 70, and immature populations are shown in Figs. 71 through 84. Results of statistical analyses are shown in Tables 7 through 13.

Populations of *N. viridula* adults sampled by sweep net method from early and late planting dates of Forrest and Bragg varieties in 1977, Bragg and Cobb in 1978, and Forrest, Bragg and Cobb in 1979 are shown in Figs. 85 through 98, respectively. Populations of *N. viridula* nymphs sampled in those years are shown in Figs. 99 through 112. Results of statistical analyses are shown in Tables 7 through 13.

Populations of *A. hilare* adults sampled by sweep net in 1977, 1978, and 1979 are shown in Figs. 113 through 126, and immature populations are shown in Figs. 127 through 140. Results of statistical analyses are shown in Tables 7 through 13.

Populations of *E. servus* adults sampled in 1977, 1978, and 1979 are shown in Figs. 141 through 154, and nymphal populations are shown in Figs. 155 through 168. Results of statistical analyses are shown in Tables 7 through 13.

Tables 14 through 16 show results of linear regression analyses of the data taken by the two methods.

Regression analyses were computed relating the number of individual developmental stages of each species captured with the sweep net to numbers captured by means of the ground cloth within the early and late plantings of Forrest Bragg and Cobb.

Results show that β_1 (the regression coefficient) is highly significant ($P<0.01$) for all cases except second instar *A. hilare* on late-planted Cobb in 1979 ($P<0.05$) and ranges from 0.237 for third instar *N. viridula* on early-planted Forrest in 1979 to 3.307 for fifth instar *E. servus* on early-planted Forrest in 1979. In most cases β_0 (the Y-intercept) was not significantly different from 0; exceptions occurred primarily on early plantings, Bragg variety, and with various developmental stages of *A. hilare*. R^2 values (coefficients of determination) expressed, in the tables as percentages, ranged from 21.4% for the third instar *N. viridula* on early-planted Bragg in 1978 to 99.3%

for female and male *E. servus* on early-planted Bragg in 1977 [correlation coefficients (r) = 0.463 and 0.996, respectively].

Discussion

Significant linear relationships between populations of second through fifth instars, males, females and combined populations of *N. viridula* collectd by sweep net and shake cloth were demonstrated by Rudd and Jensen (1977). However, until now no similar relationships had been demonstrated for populations of *A. hilare* and *E. servus*, or for combined populations of species comprising the stinkbug complex. Results presented here indicate that the mathematical relationships between paired sweep net and ground cloth samples differs not only among developmental stages, but among species, varieties and planting dates sampled, and among years. Factors for calibration of sweep net to ground cloth samples can be computed for each variety/planting date/species/developmental stage combination presented in Tables 14 through 16. However, due to the variability of the regression coefficients, the utility of such a tabulation of calibration equations (factors) is questionable. Further research is necessary on this problem to adequately characterize these relationships and their utility.

For all three species the magnitude of the regression coefficients usually increased as development proceeded. This is probably a function of the degree of aggregation of individual developmental stages as described by Todd and Herzog (1980) and Herzog et al. (1981).

Conclusions

Collection of adults and all nymphal stages of *N. viridula, A. hilare,* and *E. servus* by sweep net and ground cloth are significantly correlated. Data and regression analyses presented will allow the construction of coefficients for calibration between the methods for all development stages, on several varieties and planting dates.

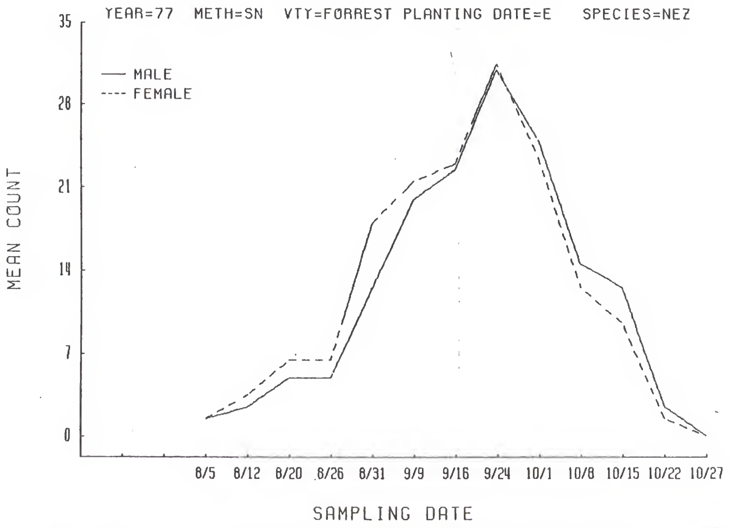


Fig. 85, Populations of *N. viridula* adults collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1977.

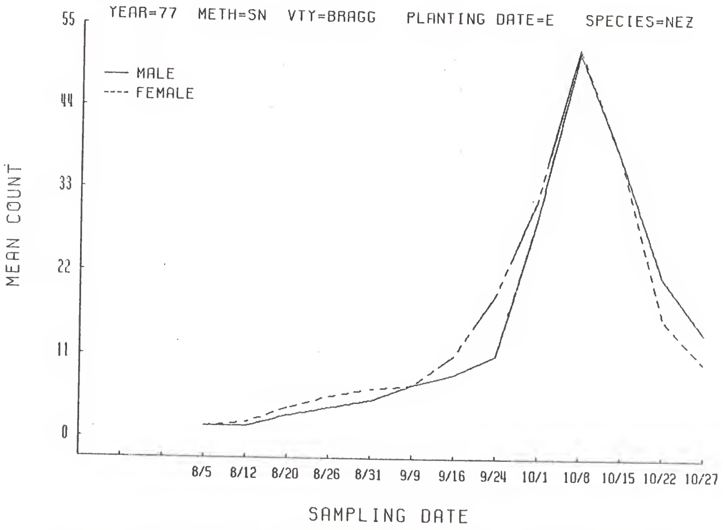


Fig. 86. Populations of *N. viridula* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1977.

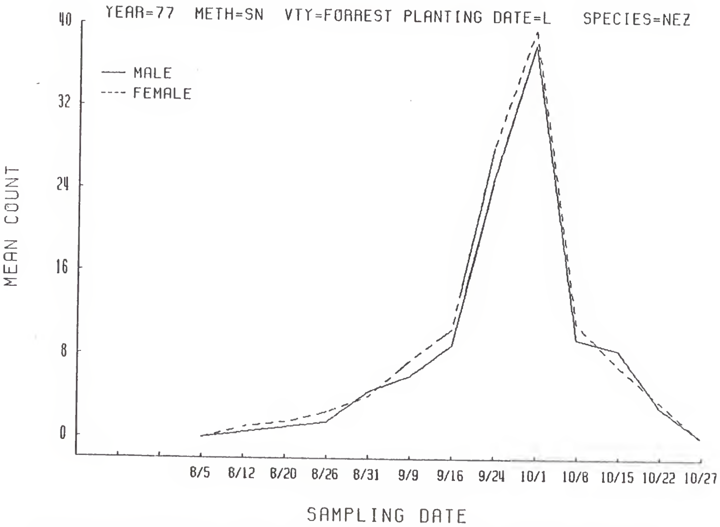


Fig. 87. Populations of *N. viridula* adults collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1977.

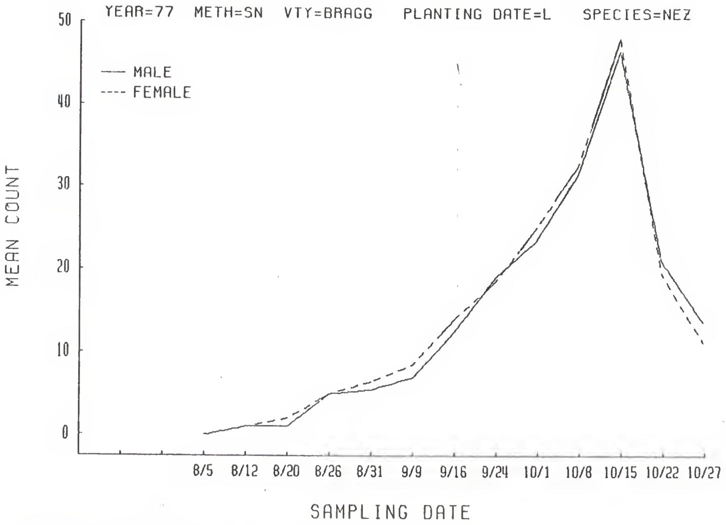


Fig. 88. Populations of *N. viridula* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1977.

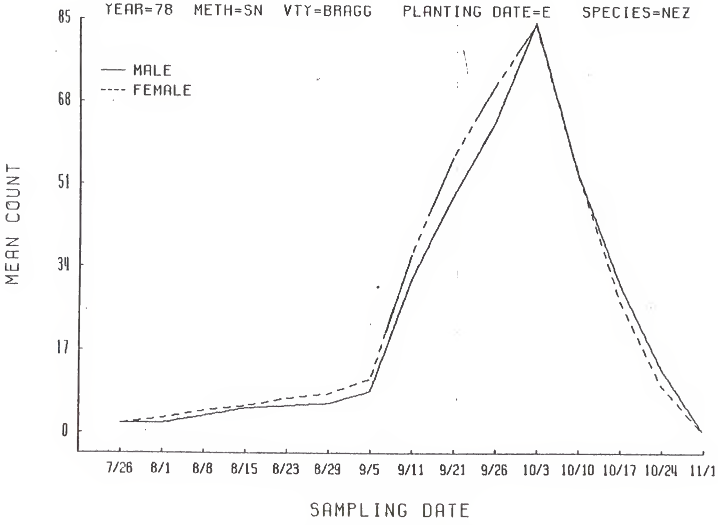


Fig. 89. Populations of *N. viridula* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1978.

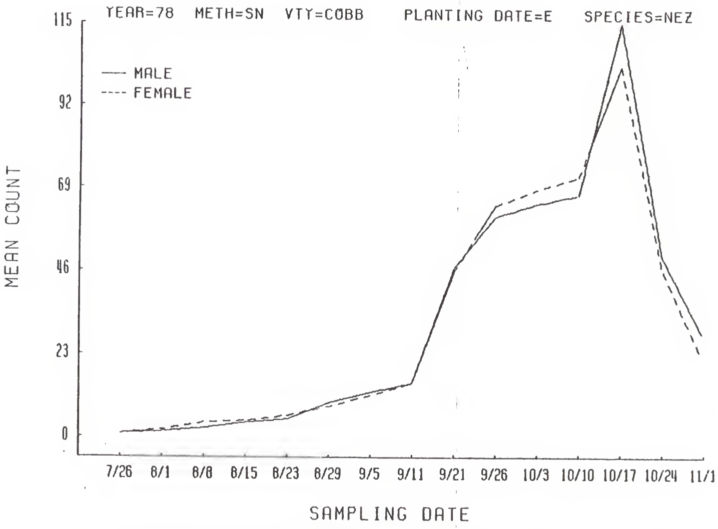


Fig. 90. Populations of *N. viridula* adults collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1978.

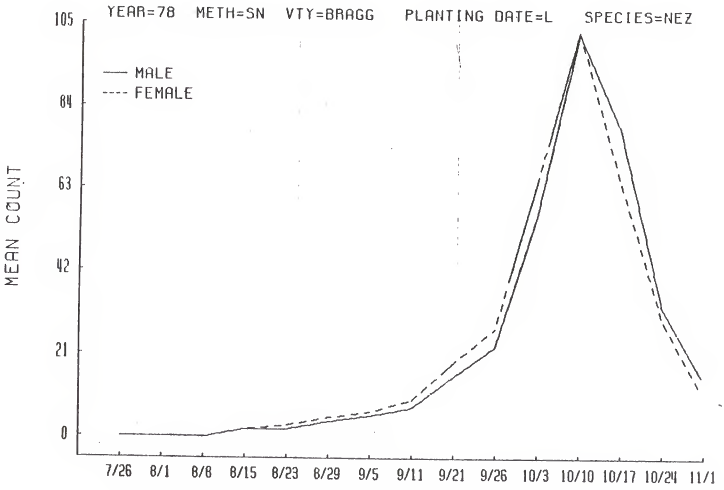


Fig. 91. Populations of *N. viridula* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1978.

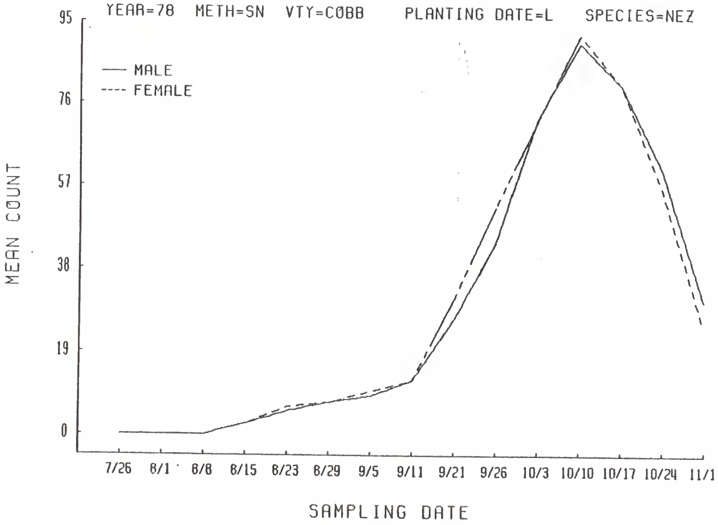


Fig. 92. Populations of *N. viridula* adults collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1978.

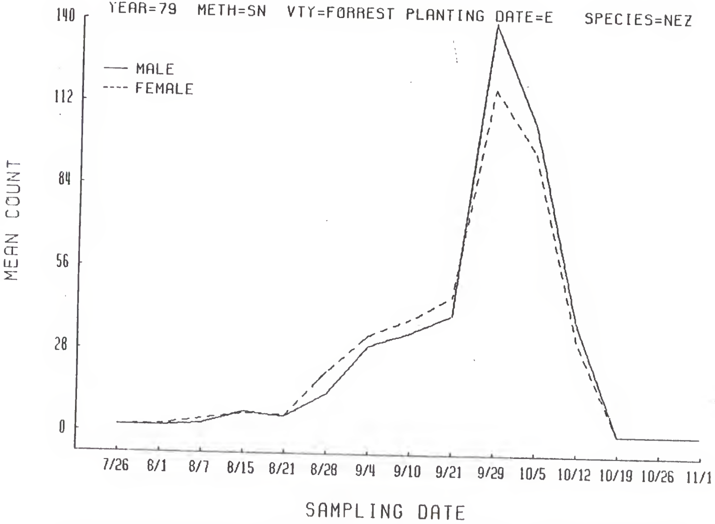


Fig. 93. Populations of *N. viridula* adults collected by sweep net on early-planted Forrest variety. quincy, Florida, 1979.

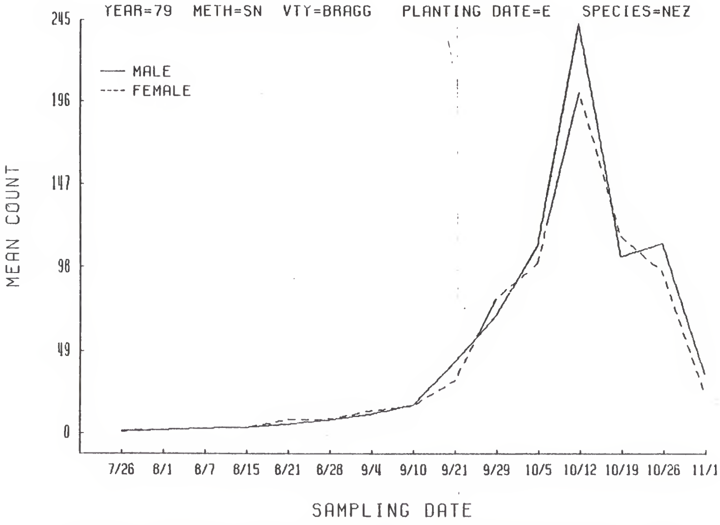


Fig. 94. Populations of *N. viridula* adults colledted by sweep net on early-planted Bragg variety. Quincy, Florida, 1979.

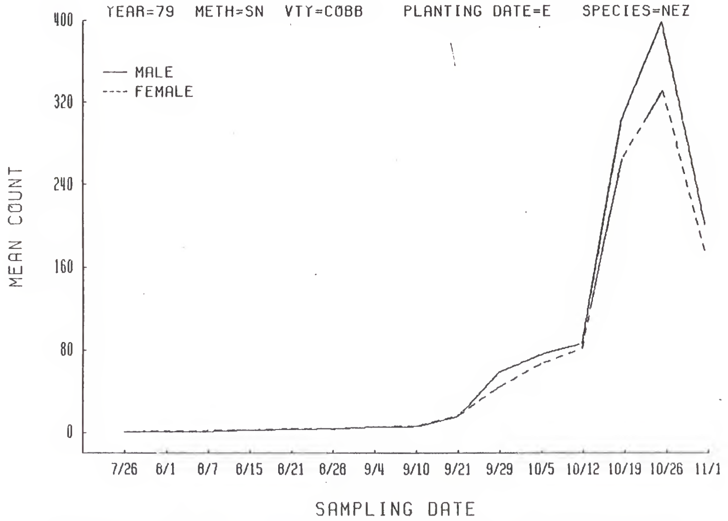


Fig. 95. Populations of *N. viridula* adults collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1979.

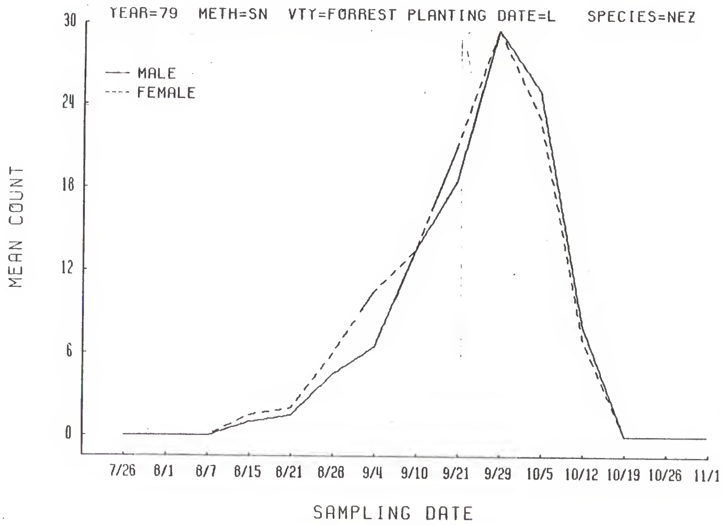


Fig. 96. Populations of *N. viridula* adults collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1979.

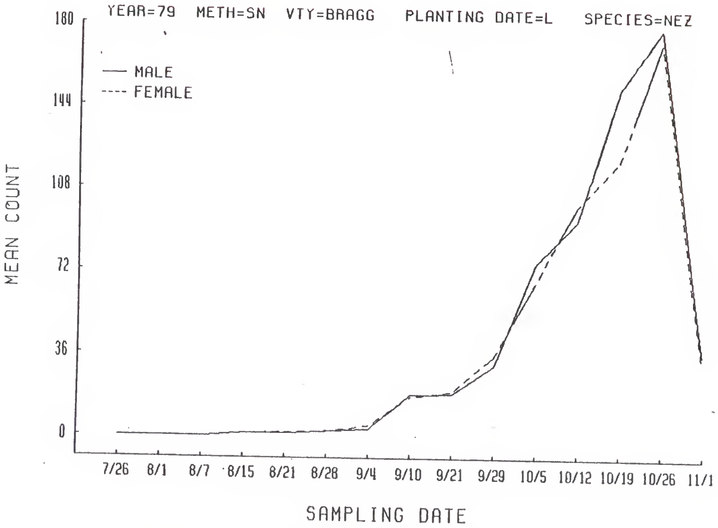


Fig. 97. Populations of *N. viridula* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1979.

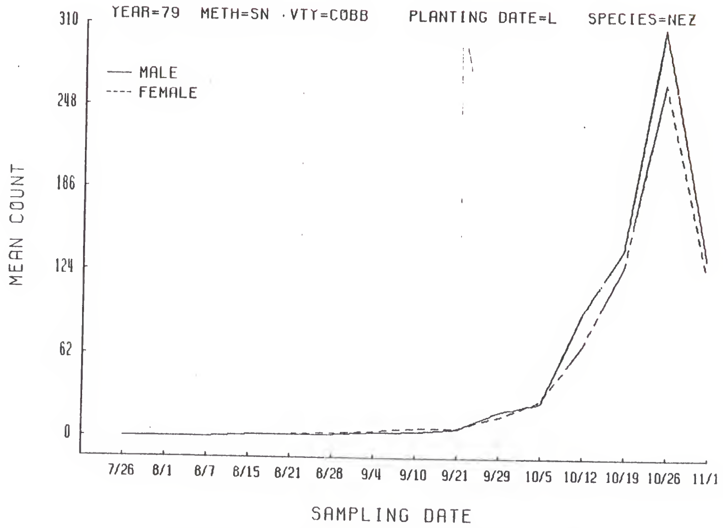


Fig. 98. Populations of *N. viridula* adults collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1979.

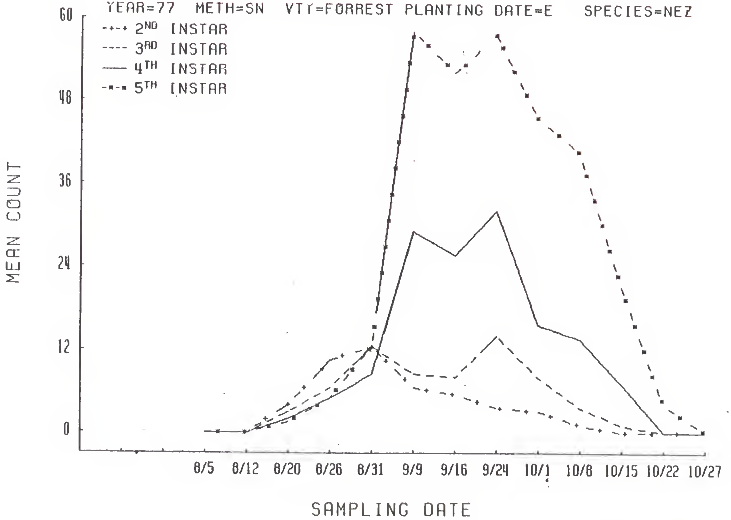


Fig. 99. Populations of *N. viridula* nymphs collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1977.

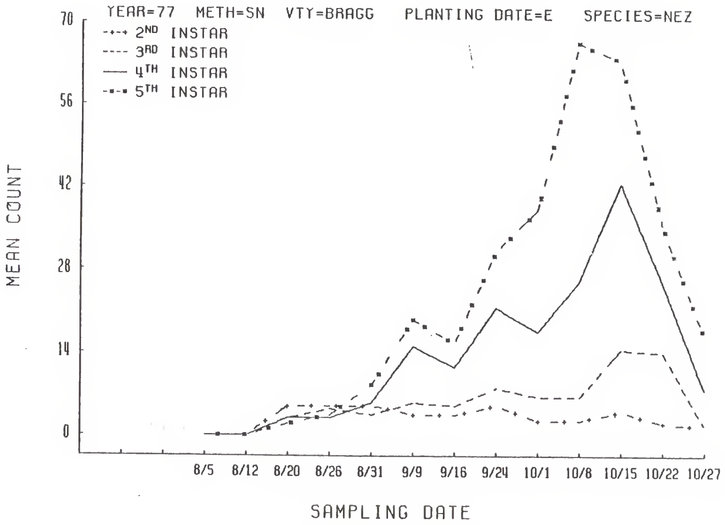


Fig. 100. Populations of *N. viridula* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1977.

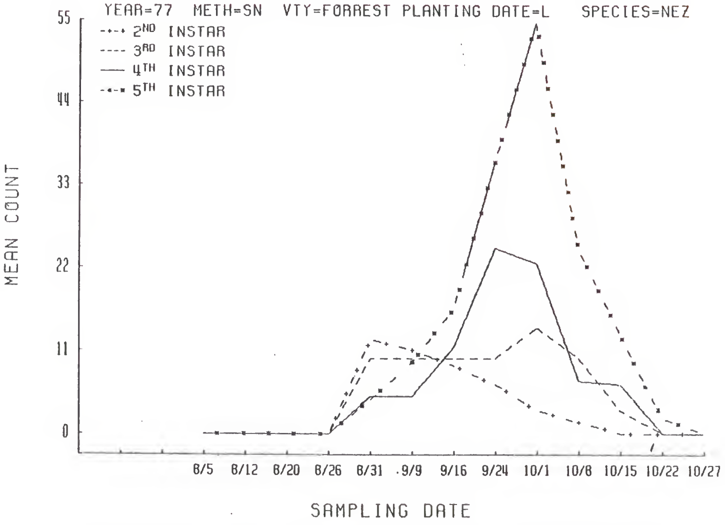


Fig. 101. Populations of *N. viridula* nymphs collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1977.

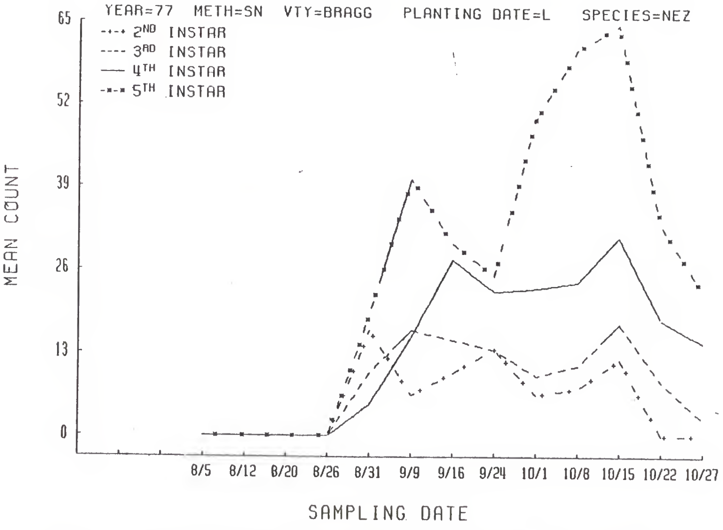


Fig. 102. Populations of *N. viridula* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1977.

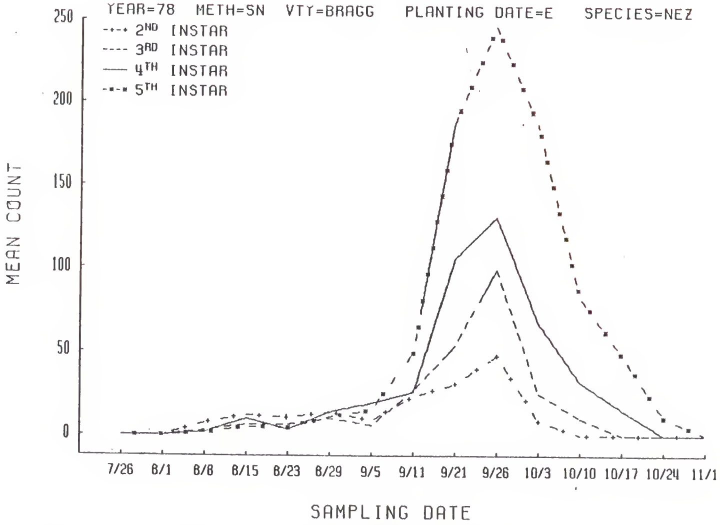


Fig. 103. Populations of *N. viridula* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1978.

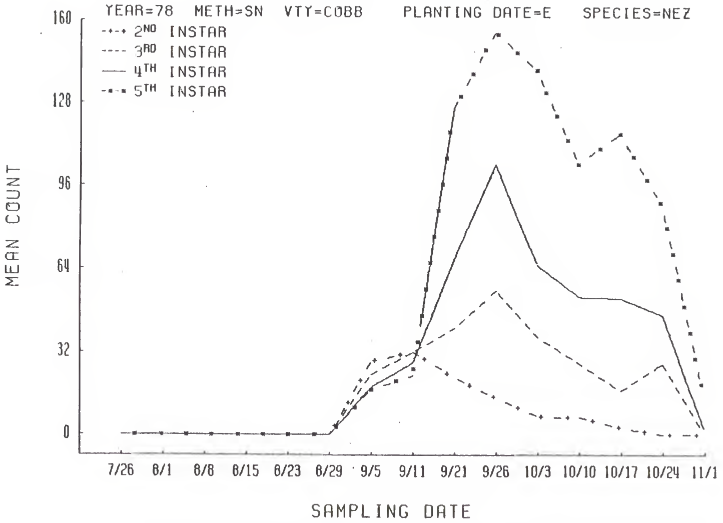


Fig. 104. Populations of *N. viridula* nymphs collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1978.

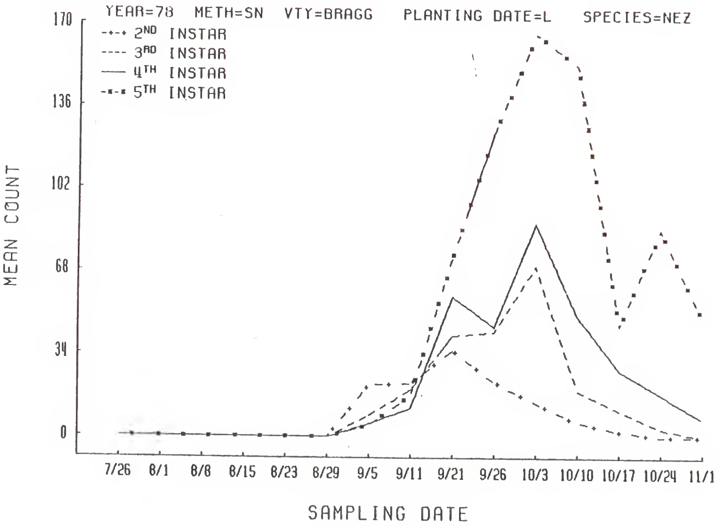


Fig. 105. Populations of *N. viridula* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1978.

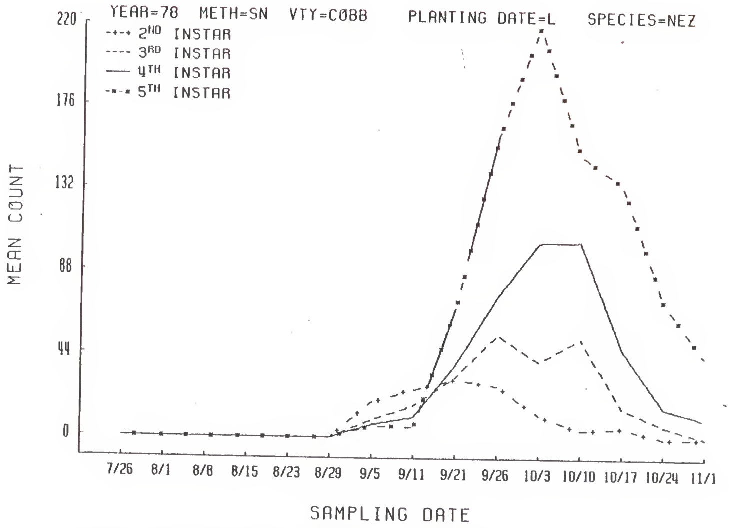


Fig. 106. Populations of *N. viridula* nymphs collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1978.

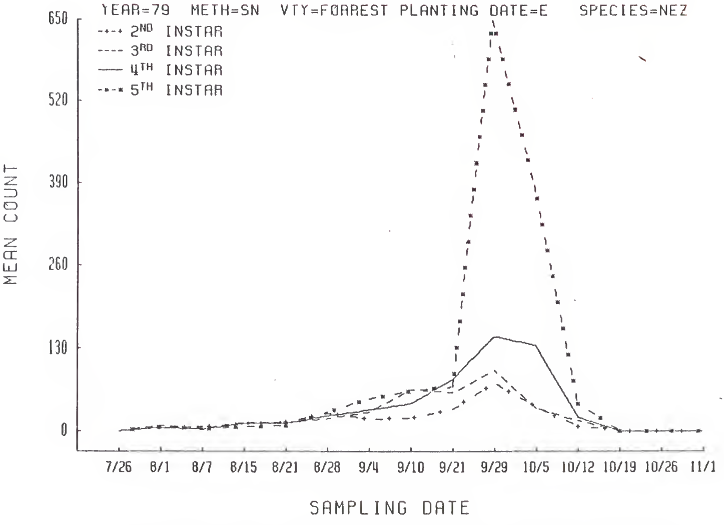


Fig. 107. Populations of *N. viridula* nymphs collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1979.

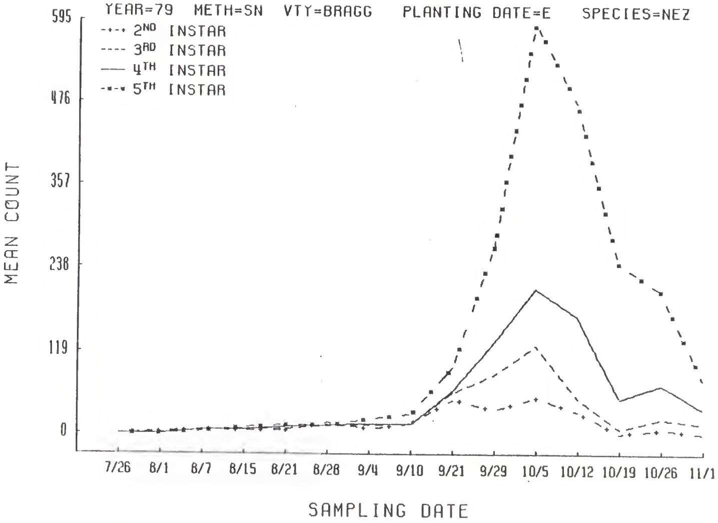


Fig. 108. Populations of *N. viridula* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1979.

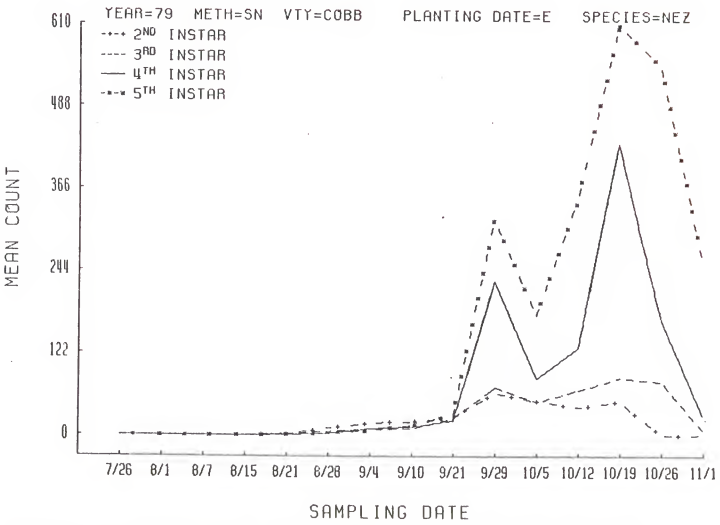


Fig. 109.. Populations of *N. viridula* nymphs collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1979.

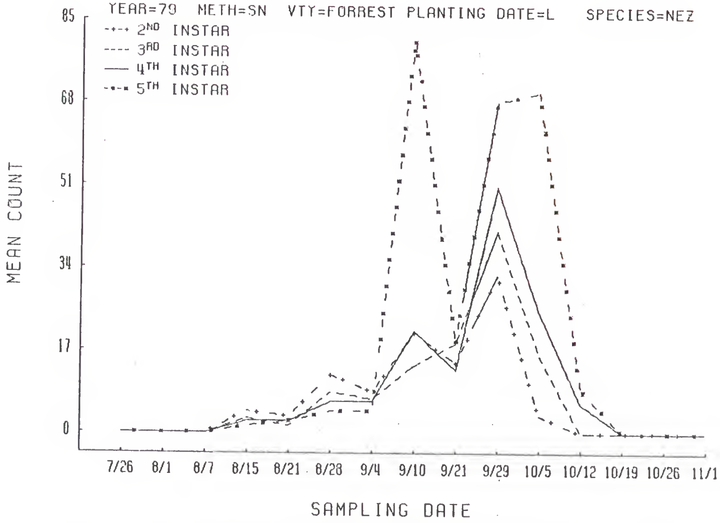


Fig. 110. Populations of *N. viridula* nymphs collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1979.

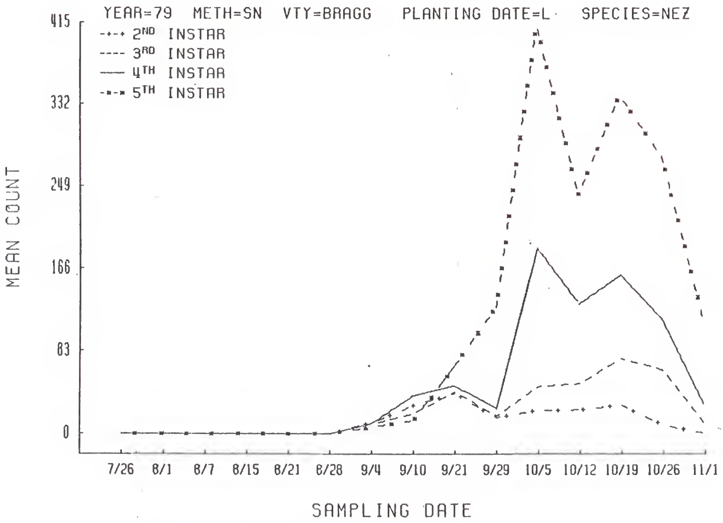


Fig. 111. Populations of *N. viridula* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1979.

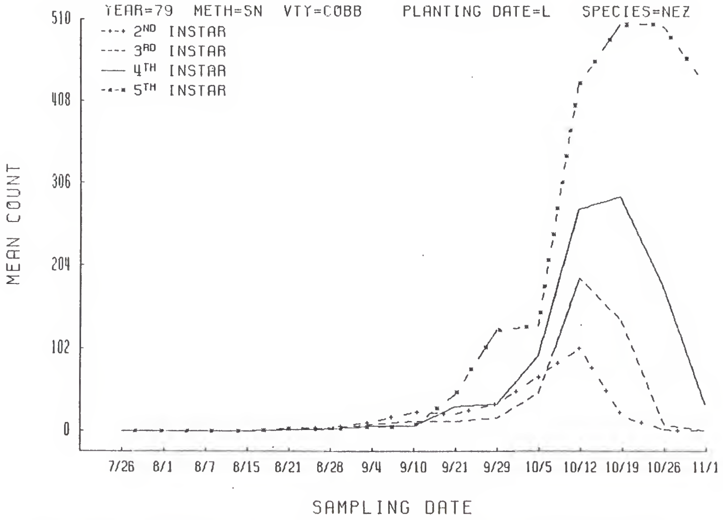


Fig. 112. Populations of *N. viridula* nymphs collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1979.

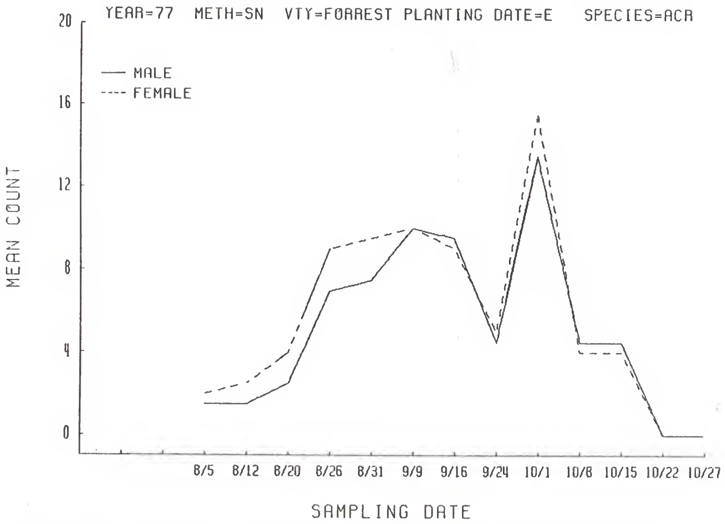


Fig. 113. Populations of *A. hilare* adults collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1977.

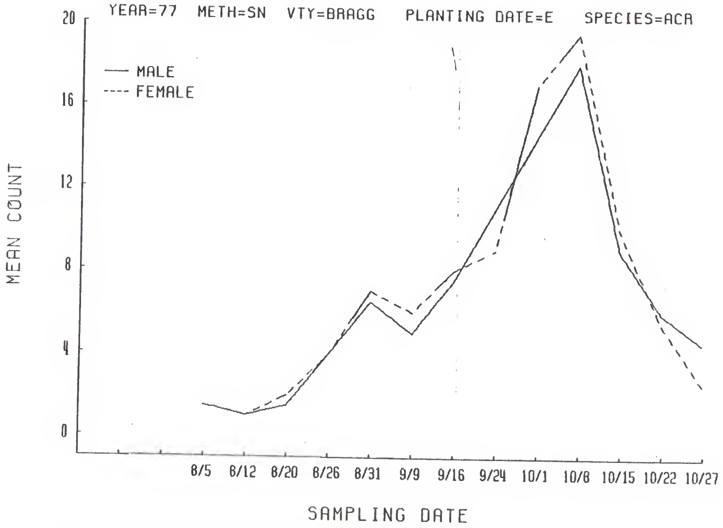


Fig. 114. Populations of *A. hilare* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1977.

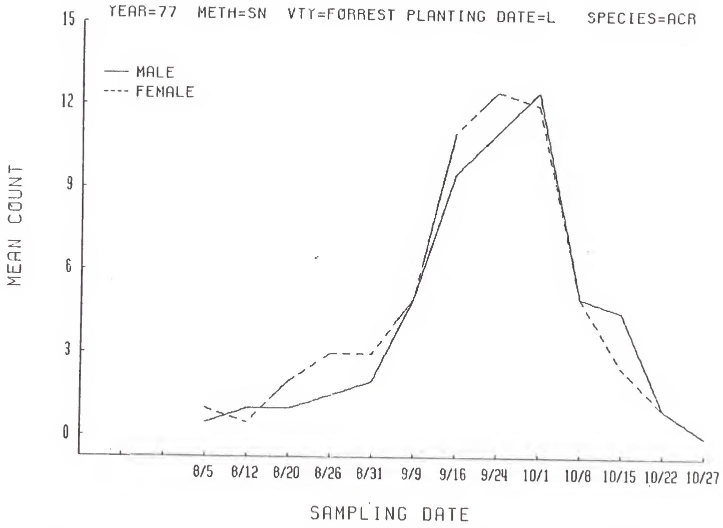


Fig. 115. Populations of *A. hilare* adults collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1977.

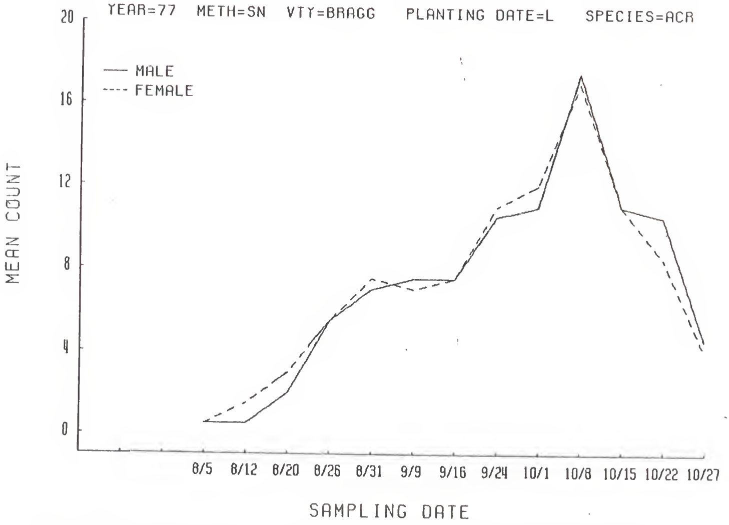


Fig. 116. Populations of *A. hilare* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1977.

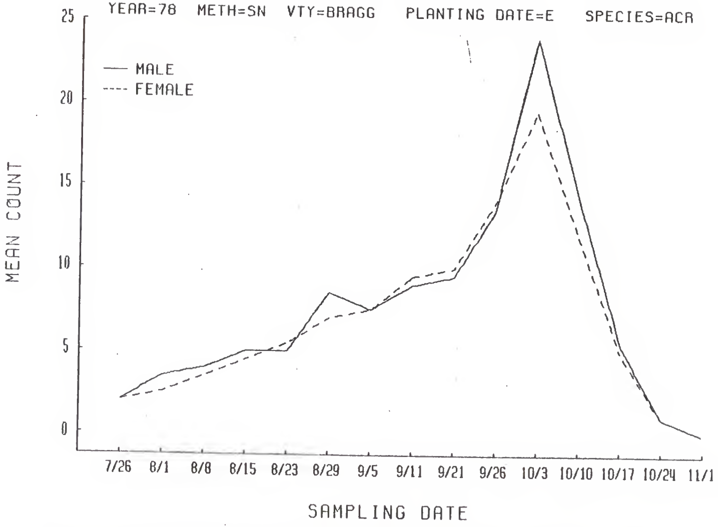


Fig. 117. Populations of *A. hilare* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1978.

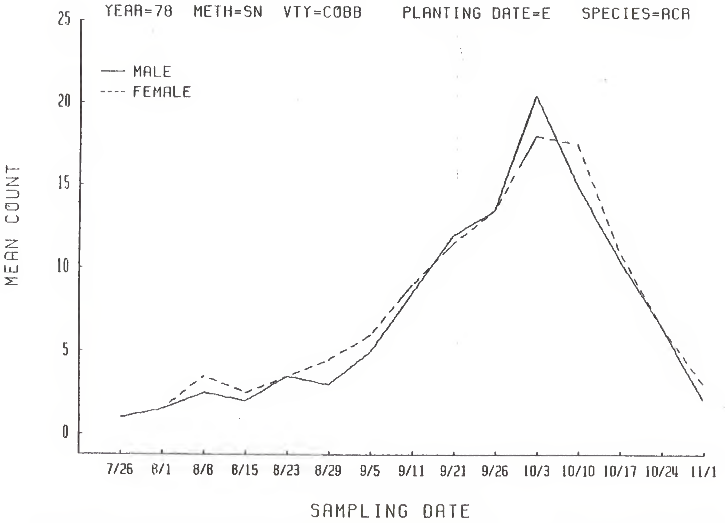


Fig. 118. Populations of *A. hilare* adults collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1978.

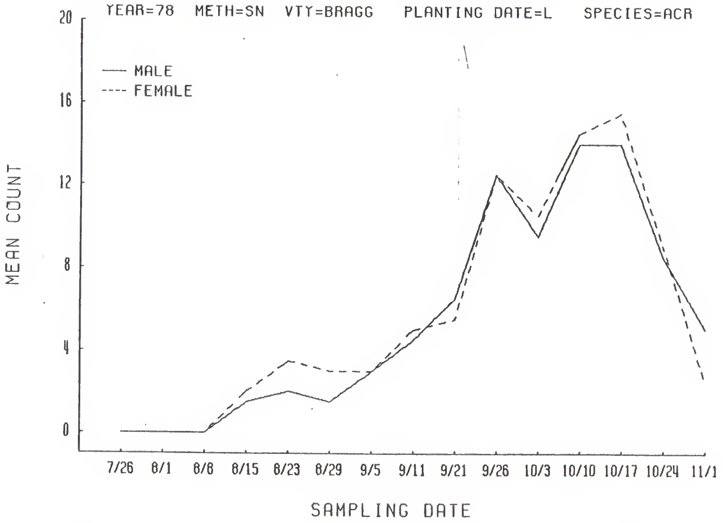


Fig. 119. Populations of *A. hilare* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1978.

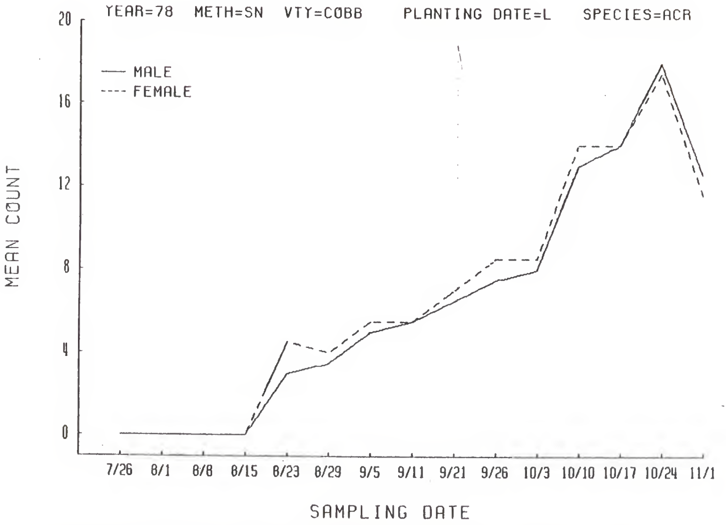


Fig. 120. Populations of *A. hilare* adults collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1978.

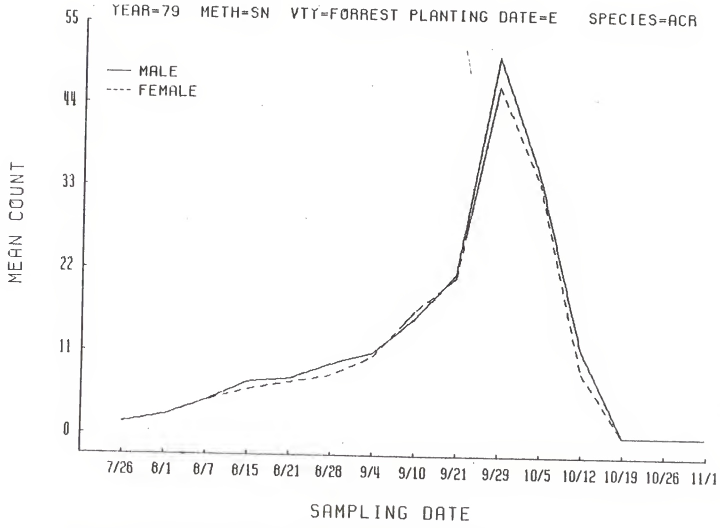


Fig. 121. Populations of *A. hilare* adults collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1979.

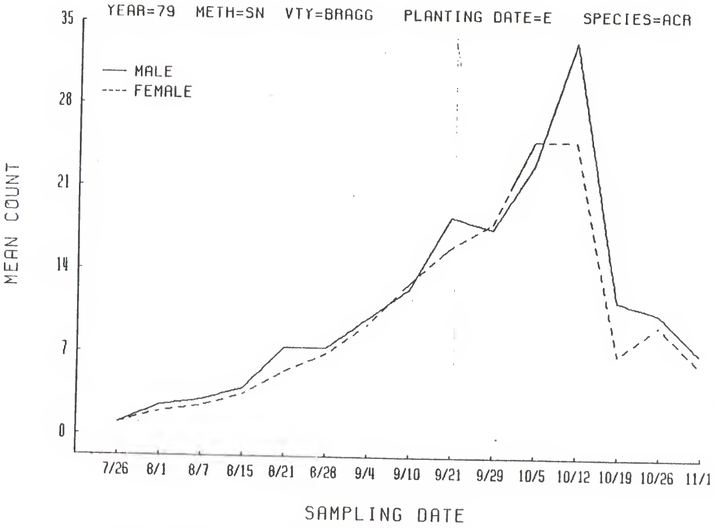


Fig. 122. Populations of *A. hilare* adults collected bu sweep net on early-planted Bragg variety. Quincy, Florida, 1979.

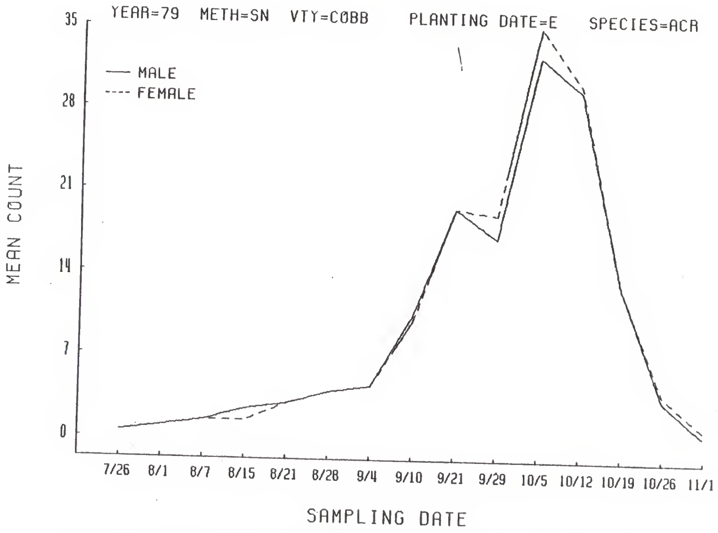


Fig. 123. Populations of *A. hilare* adults collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1979.

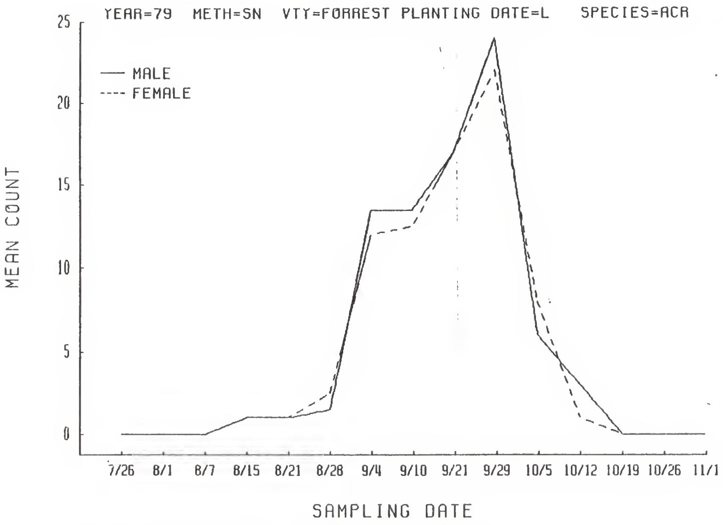


Fig. 124. Populations of *A. hilare* adults collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1979.

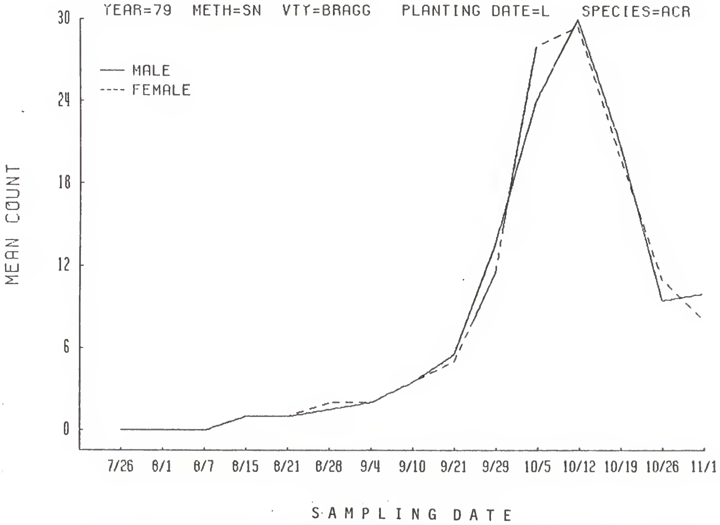


Fig. 125. Populations of *A. hilare* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1979.

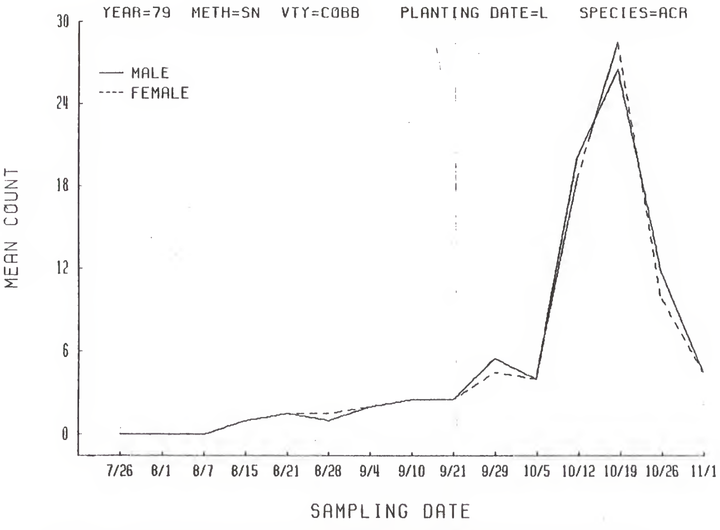


Fig. 126. Populations of *A. hilare* adults collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1979.

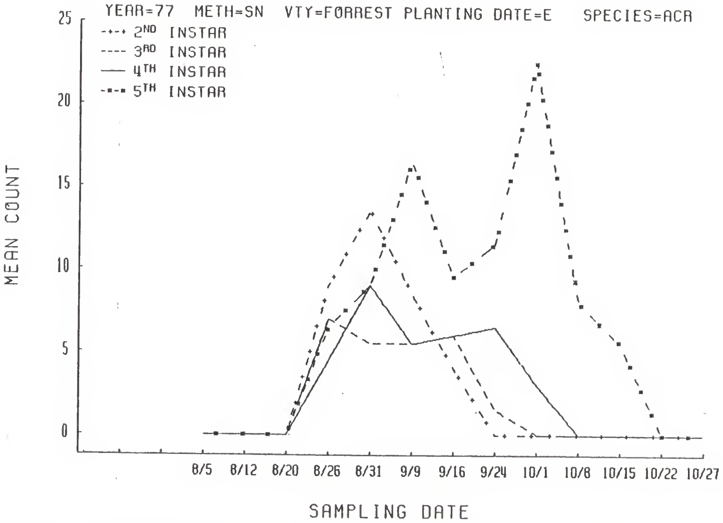


Fig. 127. Populations of *A. hilare* nymphs collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1977.

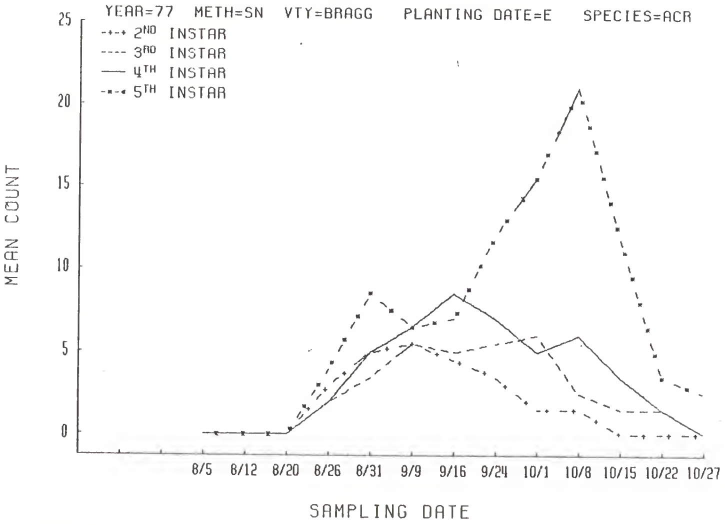


Fig. 128. Populations of *A. hilare* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1977.

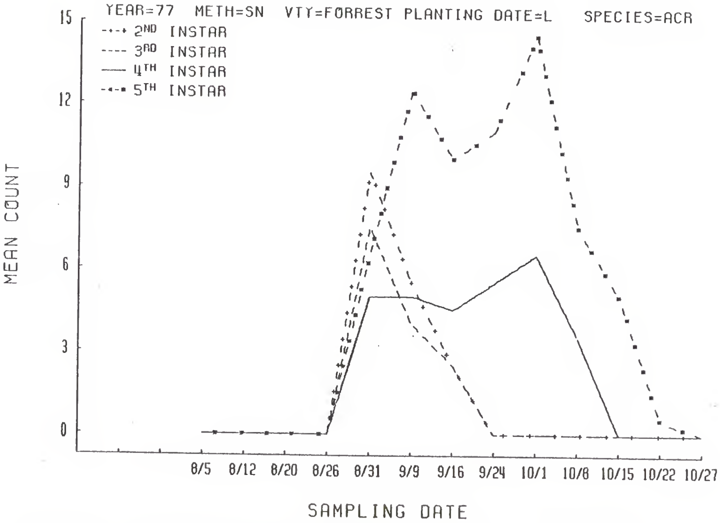


Fig. 129.. Populations of *A. hilare* nymphs collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1977.

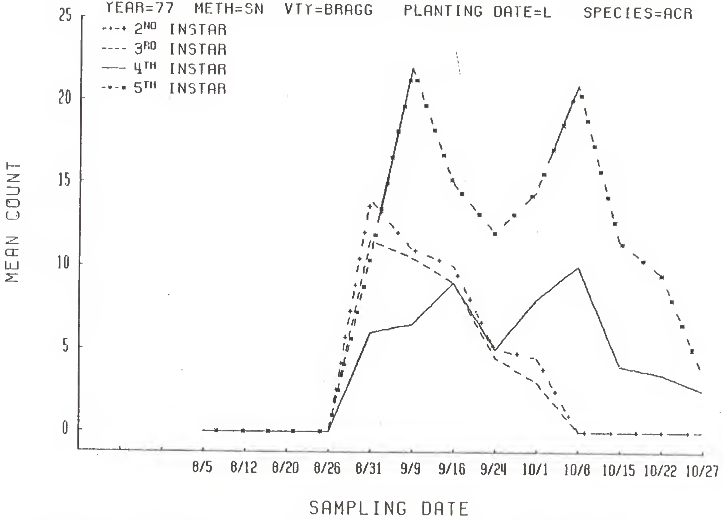


Fig. 130.. Populations of *A. hilare* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1977.

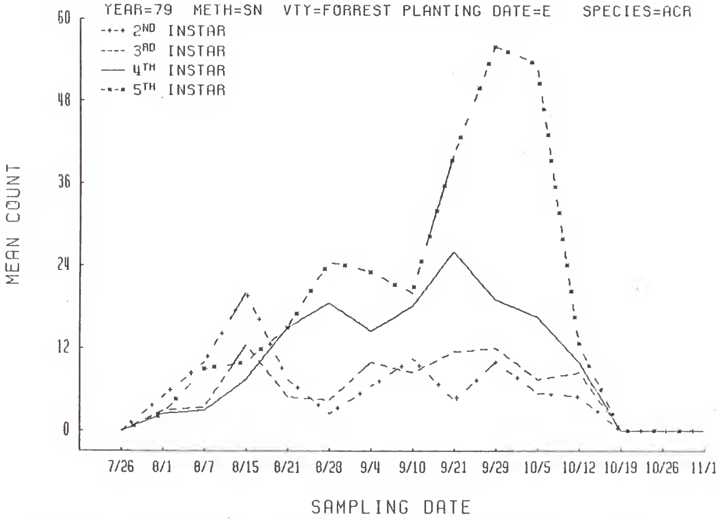


Fig. 131.. Populations of *A. hilare* nymphs collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1979.

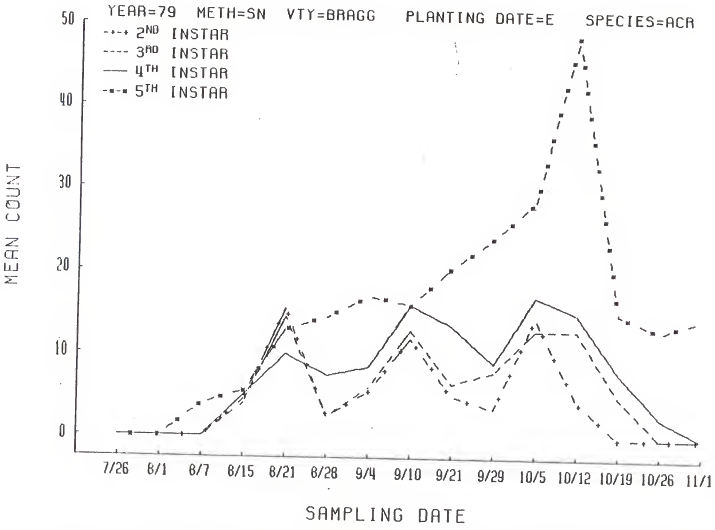


Fig. 132. Populations of *A. hilare* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1979.

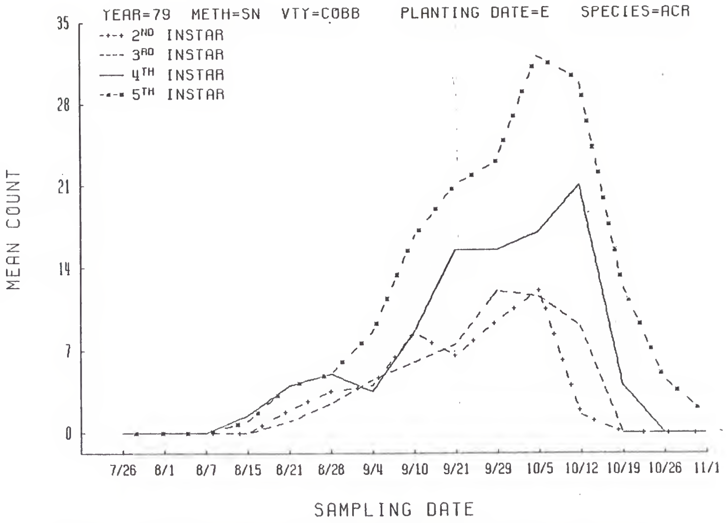


Fig. 133. Populations of *A. hilare* nymphs collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1979.

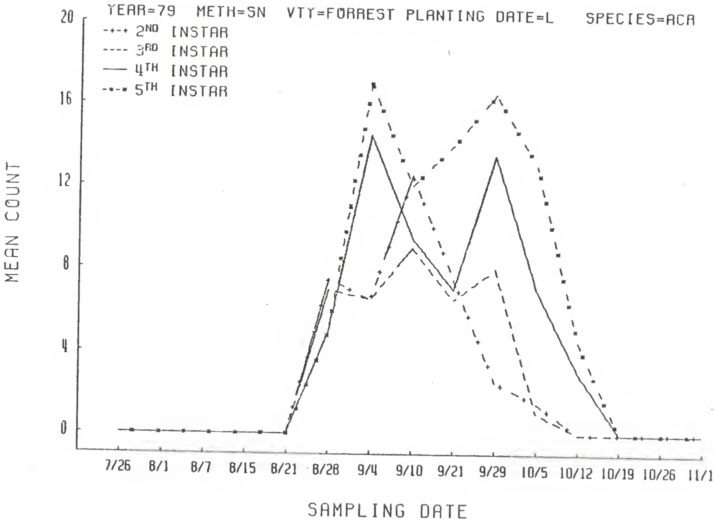


Fig.134.. Populations of *A. hilare* nymphs collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1979.

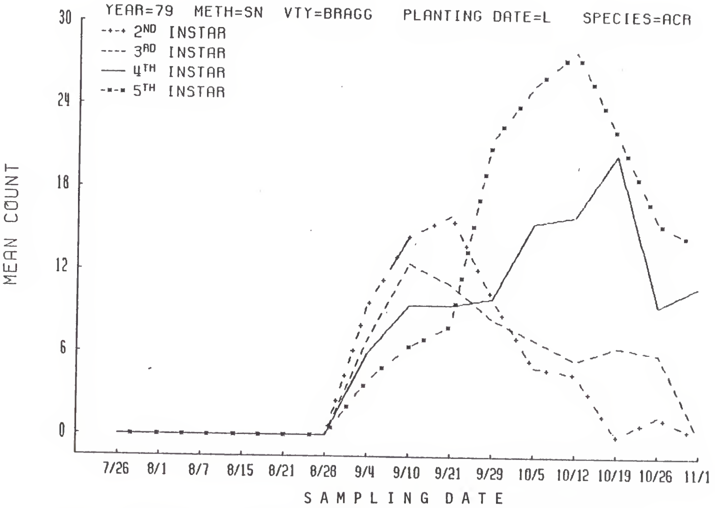


Fig. 135. Populations of *A. hilare* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1979.

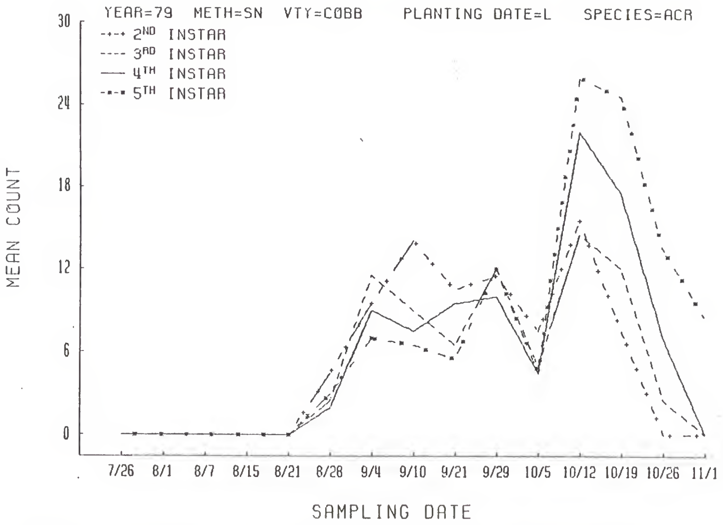


Fig.136. Populations of *A. hilare* nymphs collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1979.

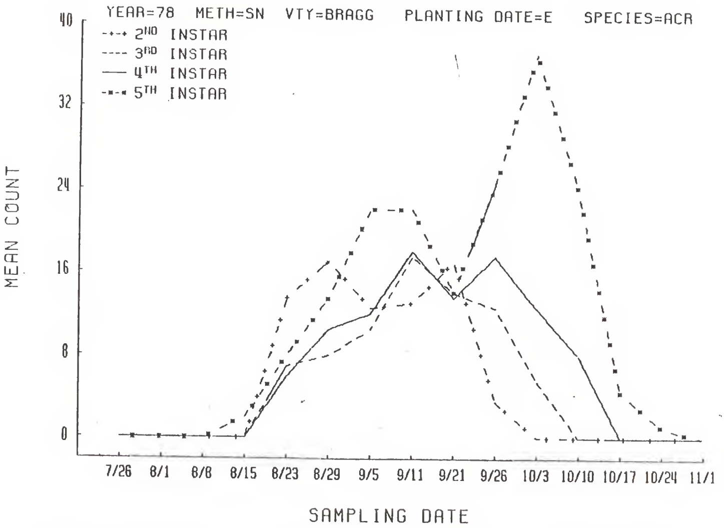


Fig. 137. Populations of *A. hilare* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1978.

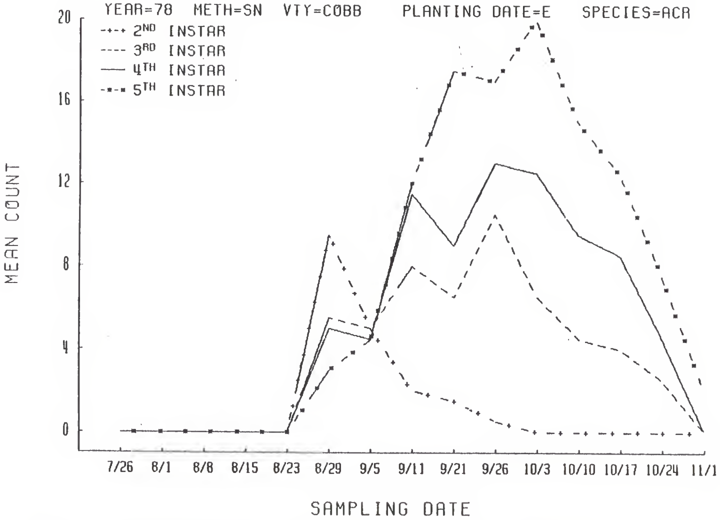


Fig. 138. Populations of *A. hilare* nymphs collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1978.

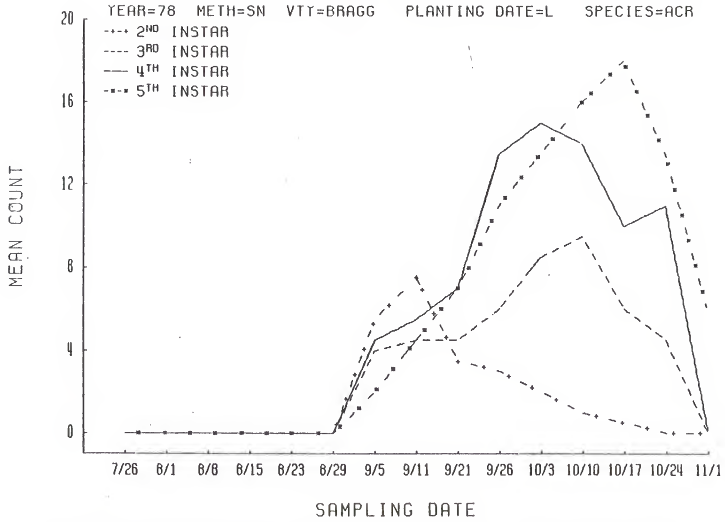


Fig. 139. Populations of *A. hilare* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1978.

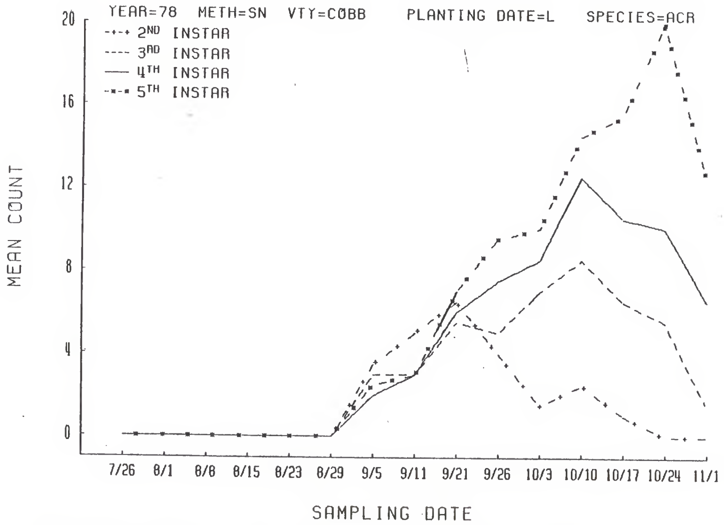


Fig. 140. Populations of *A. hilare* nymphs collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1978.

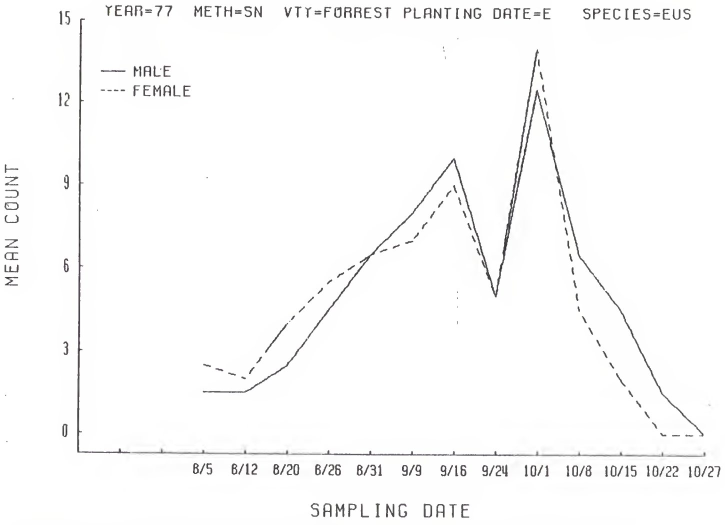


Fig. 141. Populations of *E. servus* adults collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1977.

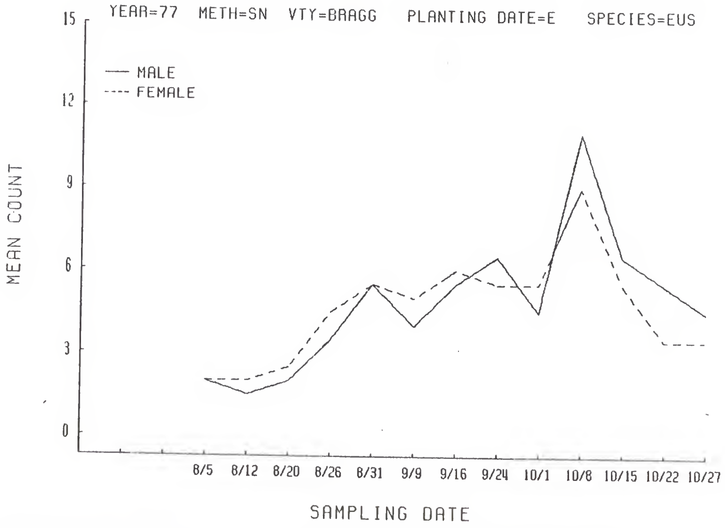


Fig. 142. Populations of *E. servus* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1977.

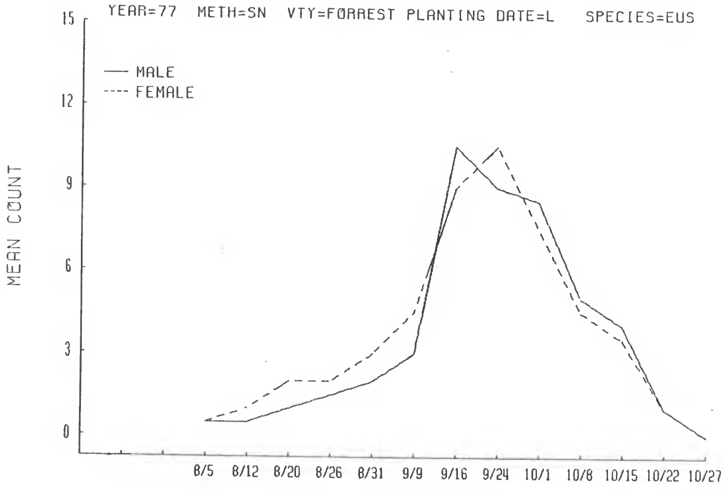


Fig. 143. Populations of *E. servus* collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1977.

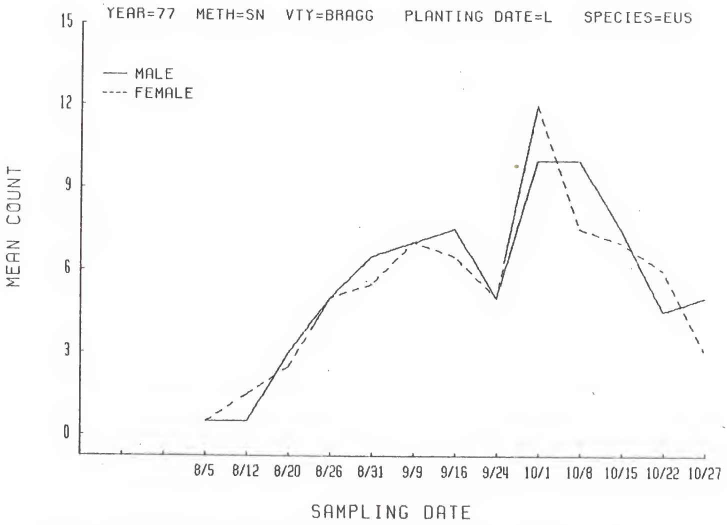


Fig.144. Populations of *E. servus* adults collected by sweep net on late-Planted Bragg variety. Quincy, Florida, 1977.

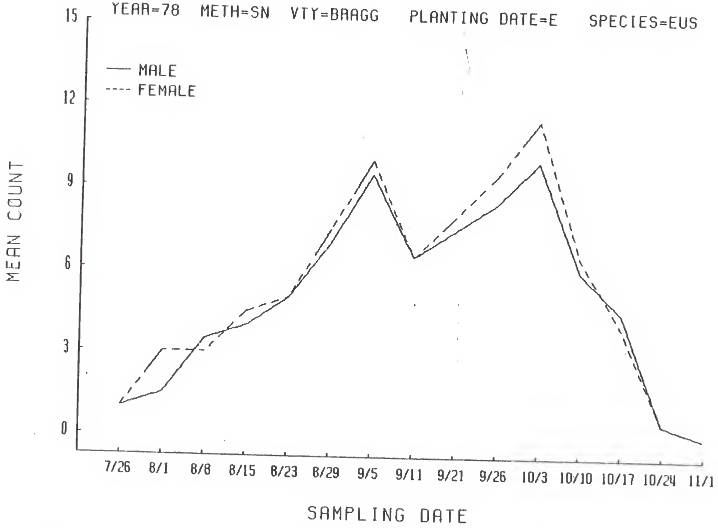


Fig. 145. Populations of *E. servus.* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1978.

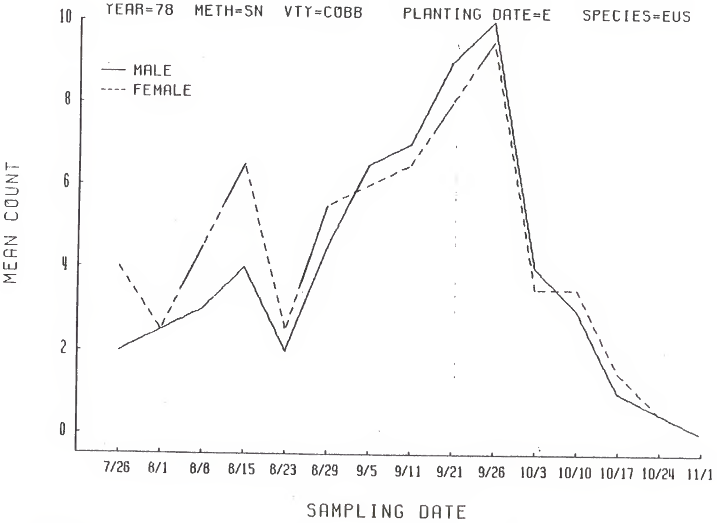


Fig. 146. Populations of *E. servus* adults collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1978.

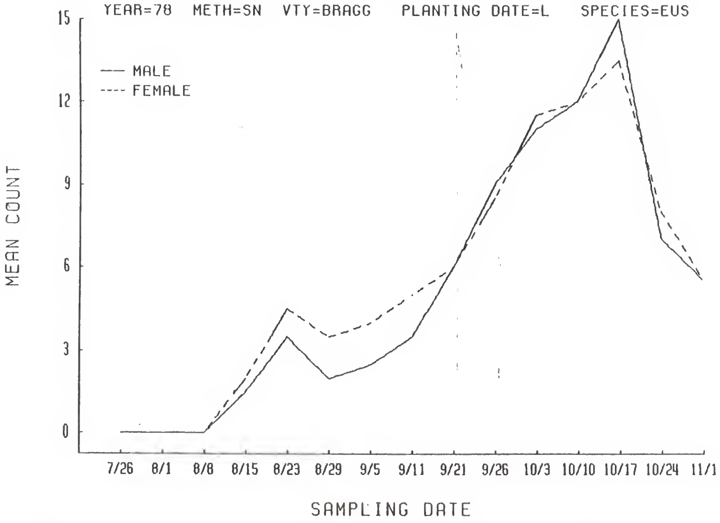


Fig. 147. Populations of *E. servus* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1978.

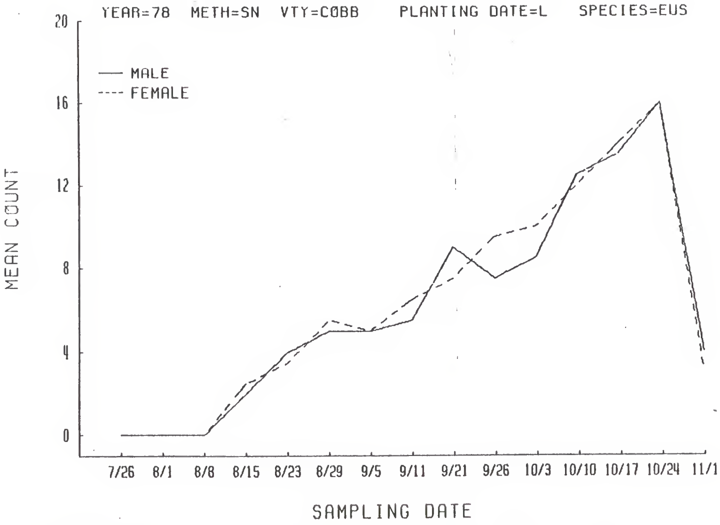


Fig. 148. Populations of *E. servus* adults collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1978.

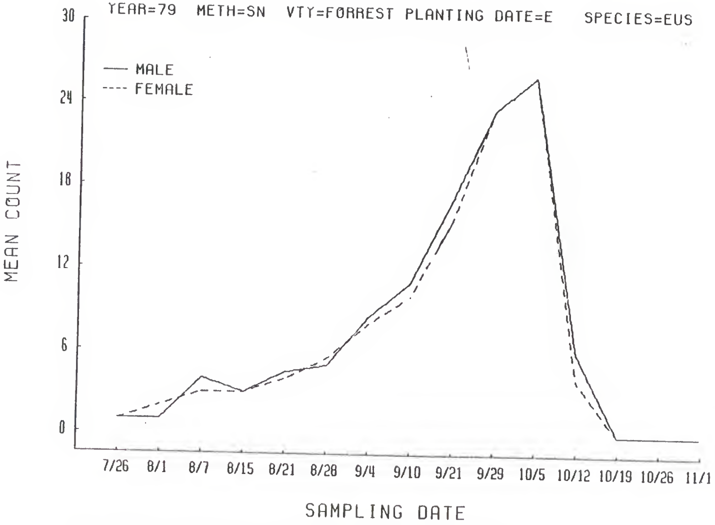


Fig. 149. Populations of *E. servus* adults collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1979.

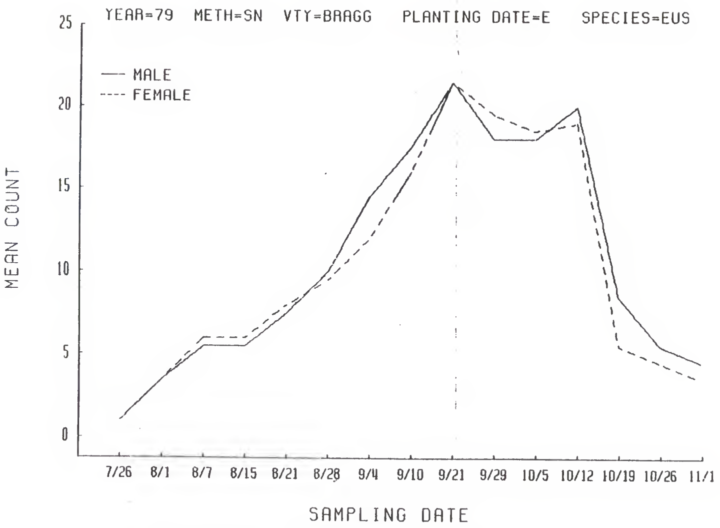


Fig. 150. Populations of *E. servus* adults collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1979.

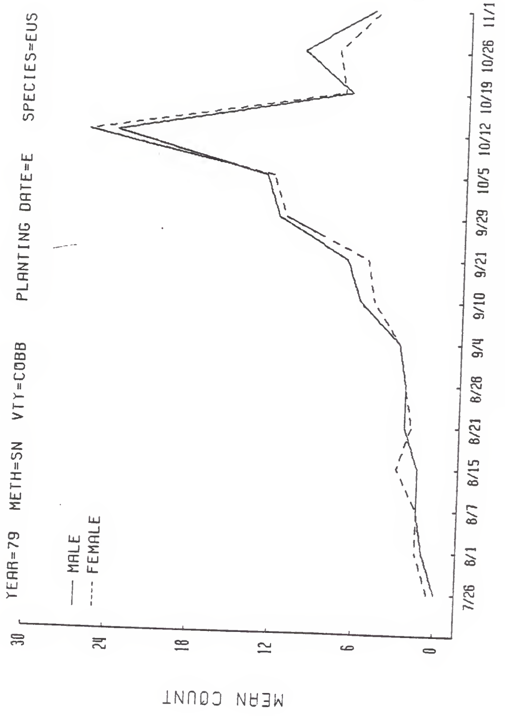


Fig. 151. Populations of *E. servus* adults collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1979.

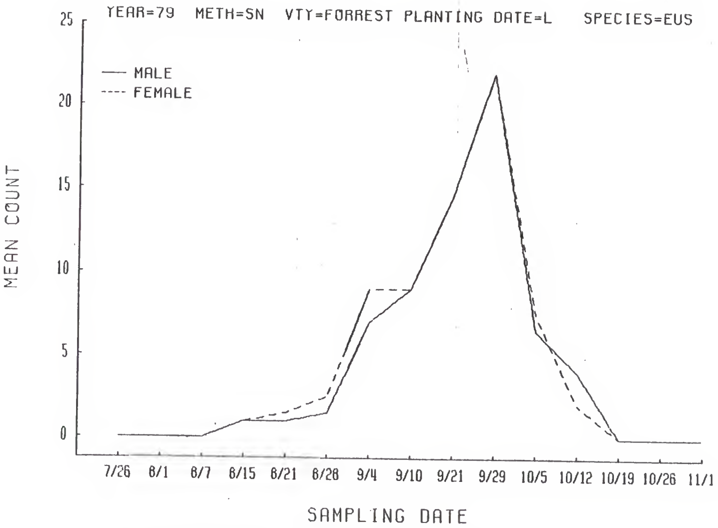


Fig. 152. Populations of *E. servus* adults collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1979.

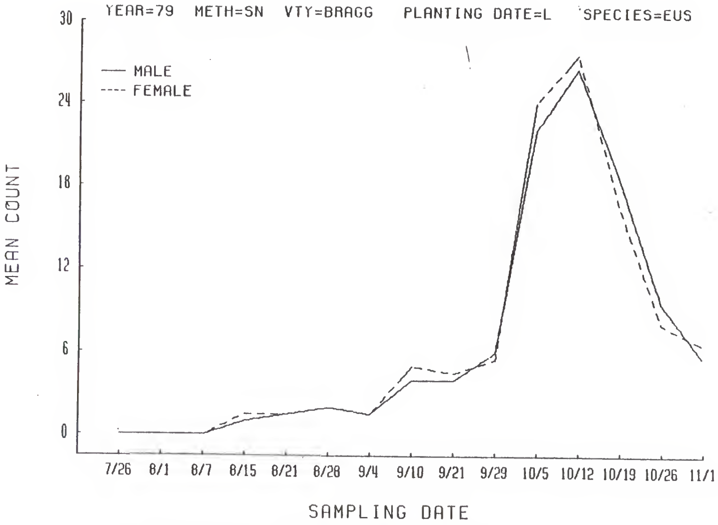


Fig. 153. Populations of *E. servus* adults collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1979.

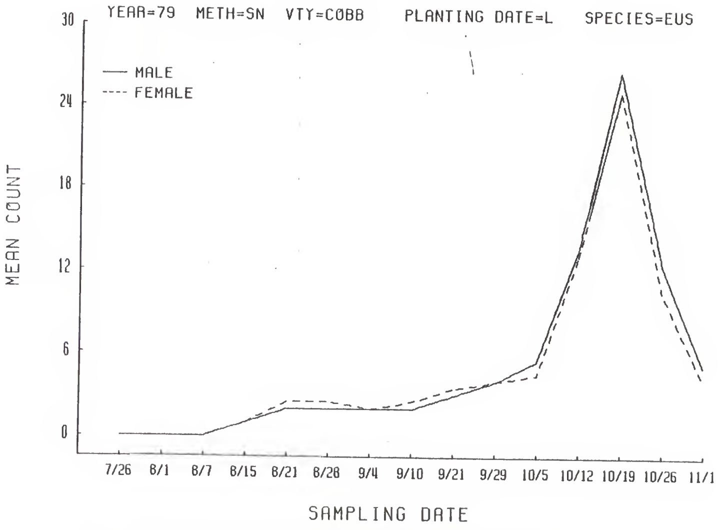


Fig. 154. Populations of *E. servus* adults collected by sweep net on late-planted Cobb variety: Quincy, Florida, 1979.

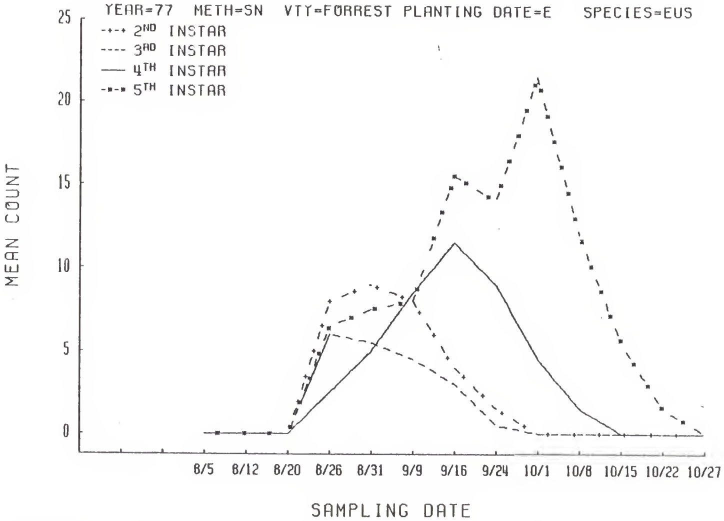


Fig. 155. Populations of *E. servus* nymphs collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1977.

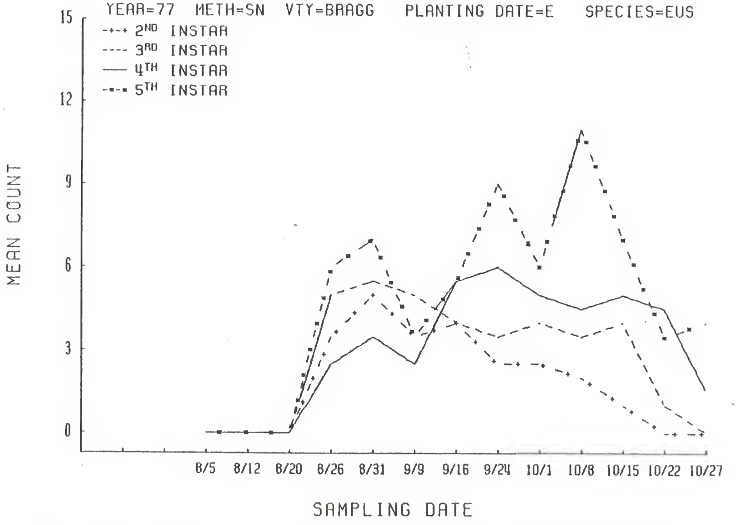


Fig. 156. Populations of *E. servus* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1977.

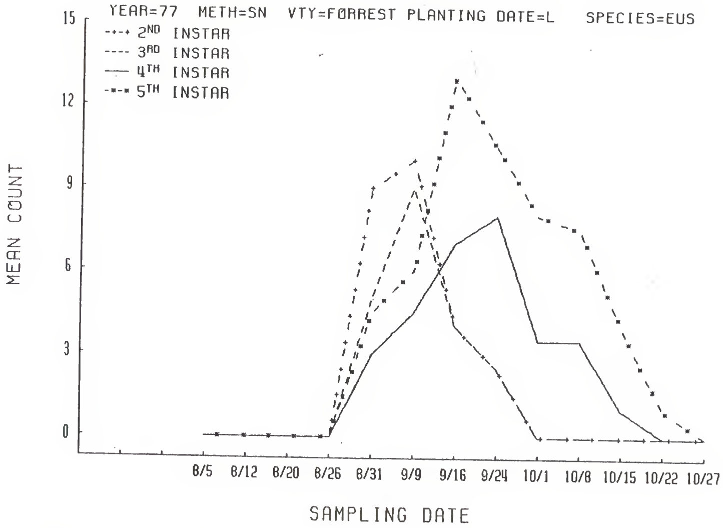


Fig. 157. Populations of *E. servus* nymphs collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1977.

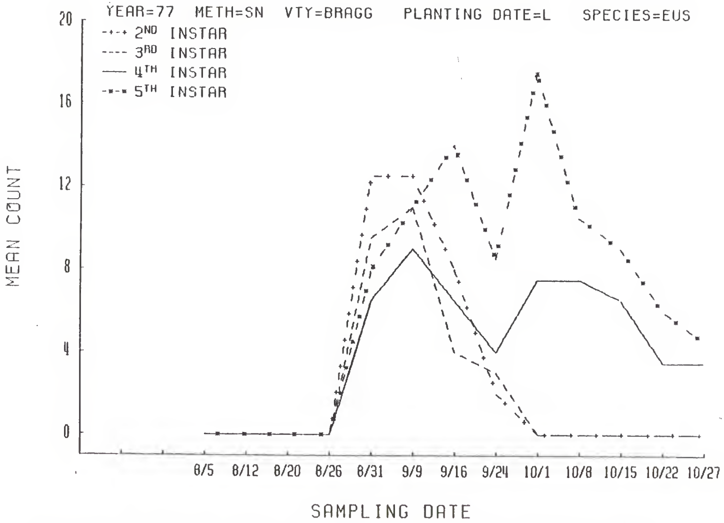


Fig. 158. Populations of *E. servus* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1977.

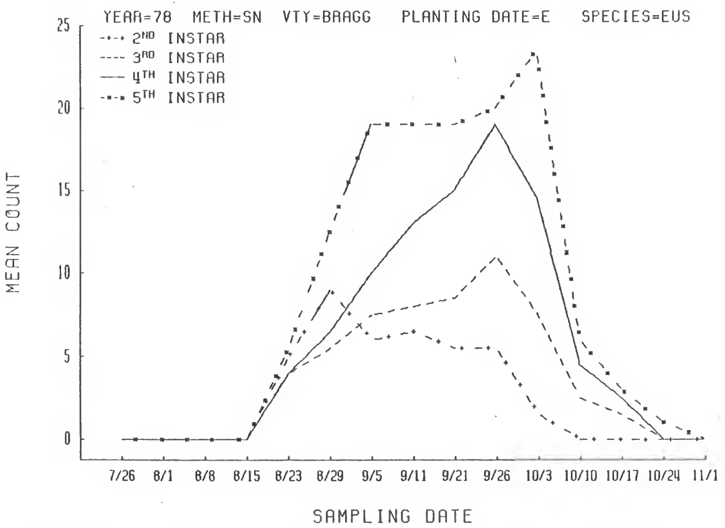


Fig. 159. Populations of *E. servus* nymphs collected by sweep net on early-planted Bragg variety. Quincy, Florida, 1978.

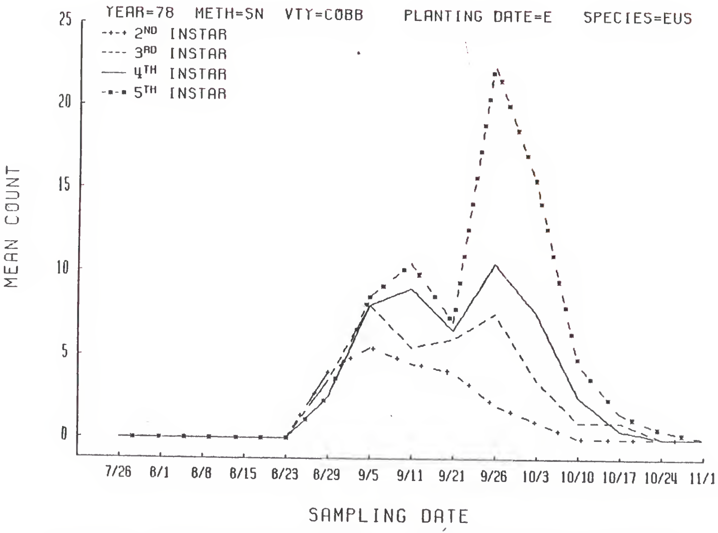


Fig. 160. Populations of *E. servus* nymphs collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1978.

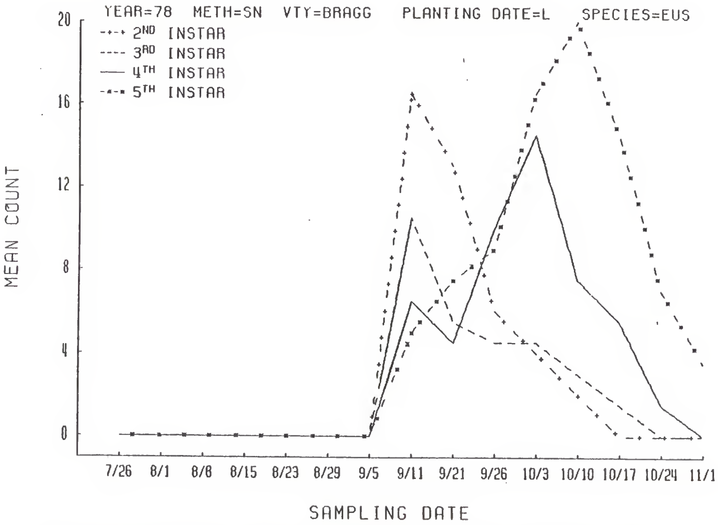


Fig. 161. Populations of *E. servus* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1978.

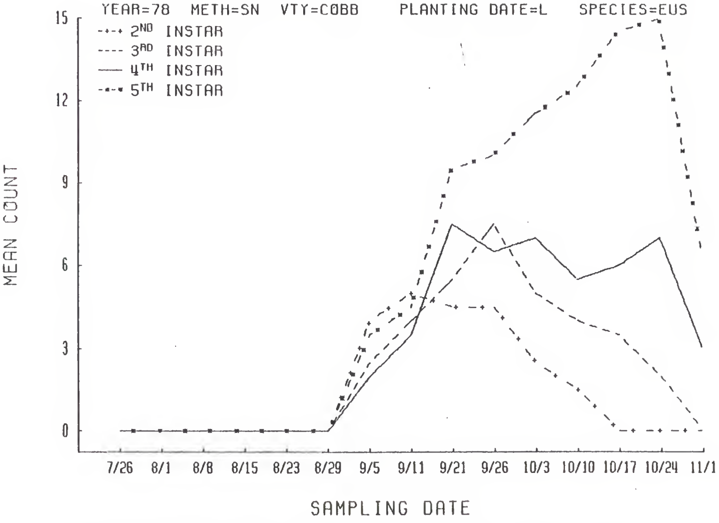


Fig.162. Populations of *E. servus* nymphs collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1978.

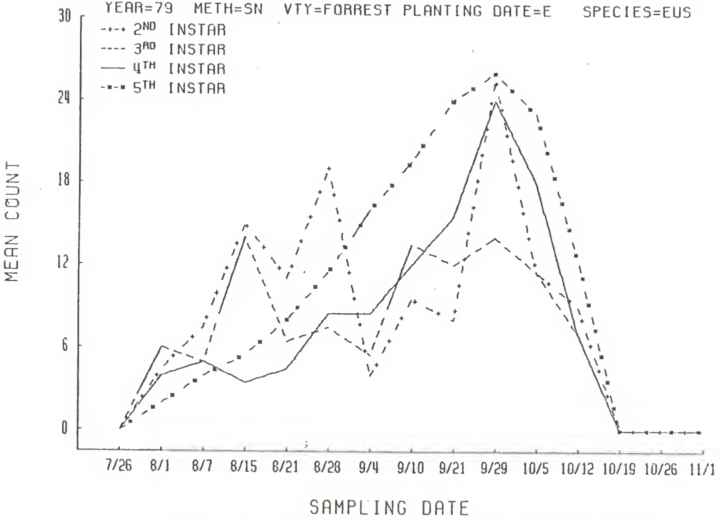


Fig.163. Populations of *E. servus* nymphs collected by sweep net on early-planted Forrest variety. Quincy, Florida, 1979.

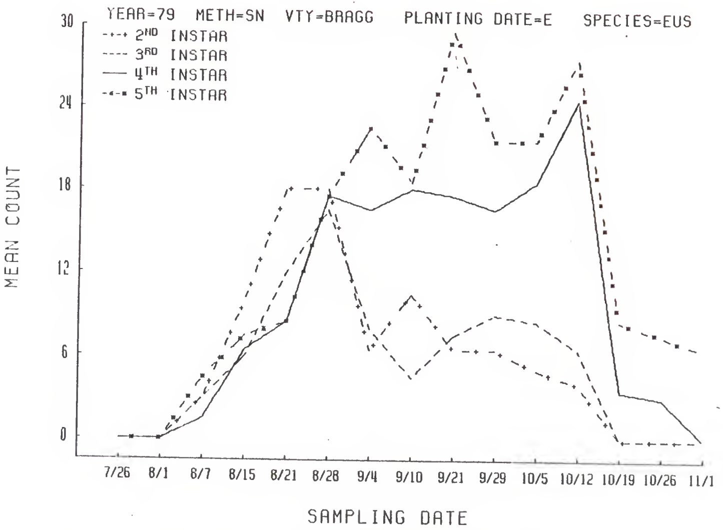


Fig. 164. Populations of *E. servus* nymphs colledted by sweep net on early-planted Bragg variety. Quincy, Florida, 1979.

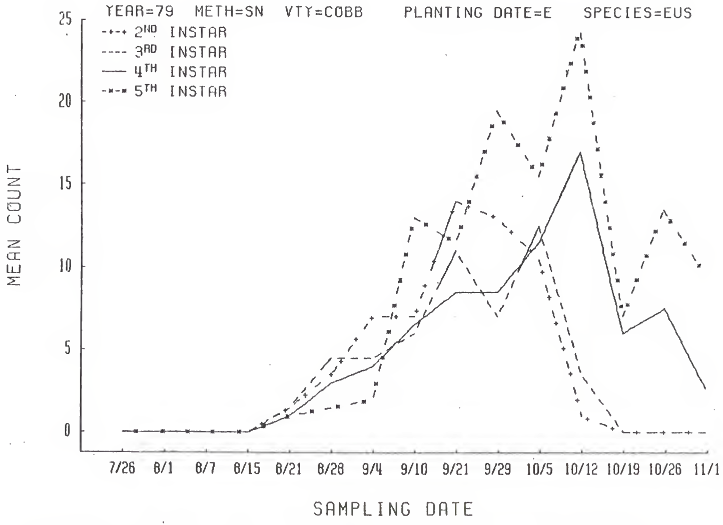


Fig. 165. Populations of *E. servus* nymphs collected by sweep net on early-planted Cobb variety. Quincy, Florida, 1979.

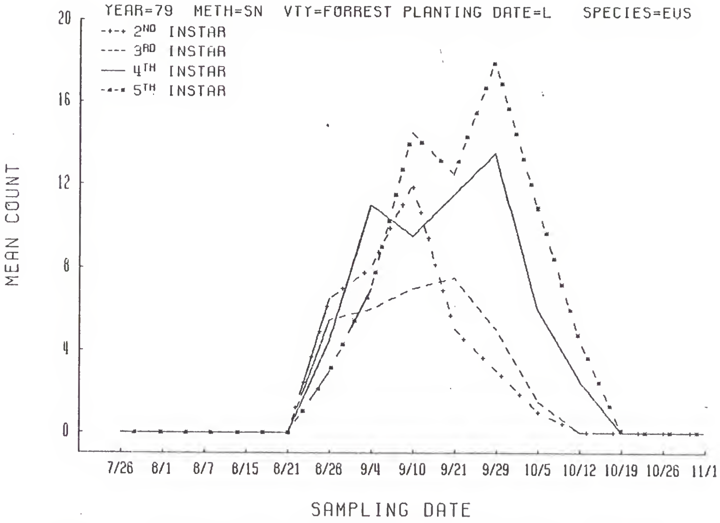
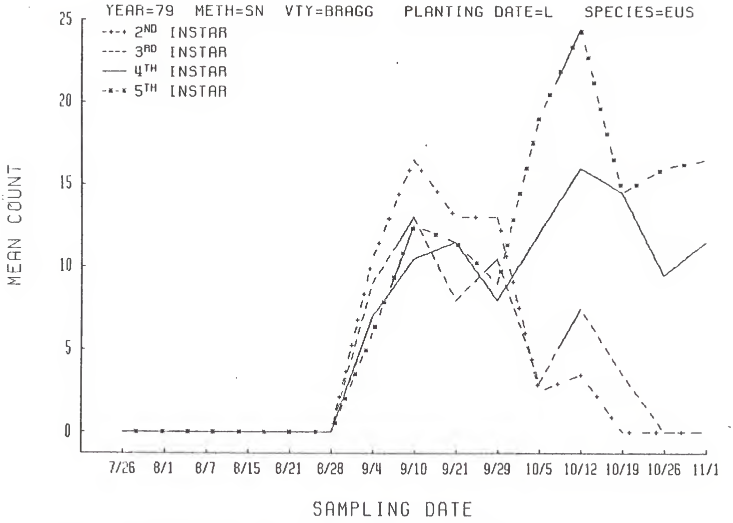


Fig. 166. Populations of *E. servus* nymphs collected by sweep net on late-planted Forrest variety. Quincy, Florida, 1979.



Fib. 167. Populations of *E. servus* nymphs collected by sweep net on late-planted Bragg variety. Quincy, Florida, 1979.

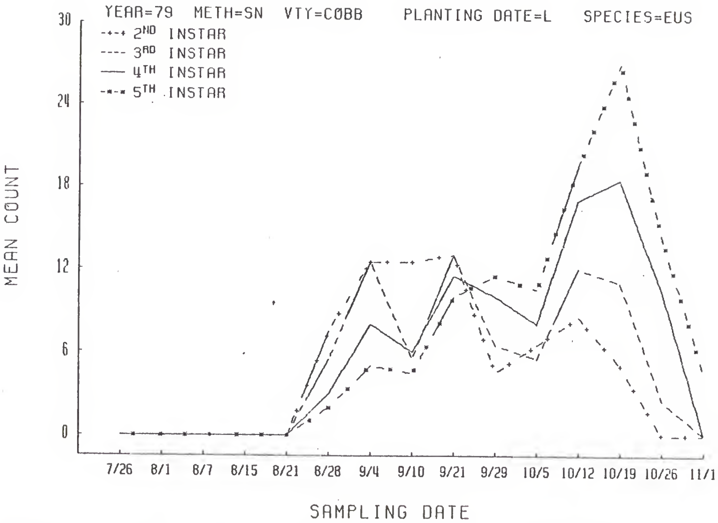


Fig. 168. Populations of *E. servus* nymphs collected by sweep net on late-planted Cobb variety. Quincy, Florida, 1979.

Table 7. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Forrest variety. Quincy, Florida, 1977.

	Planting Date	Estimate		$H_0:\beta_i = 0$		N =
		β_0	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	0.013	1.420	NS	**	88.8
	late	0.028	1.363	NS	**	87.4
Male	early	0.058	1.133	NS	**	74.0
	late	0.025	1.465	NS	**	88.5
Fifth	early	-0.028	1.554	NS	**	91.6
	late	-0.014	1.246	NS	**	96.3
Fourth	early	-0.004	1.108	NS	**	90.3
	late	0.015	0.954	NS	**	86.7
Third	early	-0.013	0.898	NS	**	91.5
	late	-0.017	0.816	NS	**	88.6
Second	early	-0.031	0.953	NS	**	91.2
	late	-0.22	0.702	NS	**	79.8
A. hilare						
Female	early	0.011	1.491	NS	**	88.2
	late	0.017	1.536	NS	**	88.6
Male	early	0.047	1.477	NS	**	89.2
	late	0.032	1.344	NS	**	90.0
Fifth	early	-0.007	1.573	NS	**	95.0
	late	0.019	0.989	NS	**	85.4
Fourth	early	-0.013	1.131	NS	**	93.5
	late	0.000	0.945	NS	**	73.0
Third	early	-0.013	0.781	NS	**	93.0
	late	-0.019	0.709	NS	**	73.0
Second	early	-0.013	0.692	NS	**	87.5
	late	-0.011	0.716	NS	**	90.0
E. servus						
Female	early	0.151	1.712	*	**	85.5
	late	-0.039	1.910	NS	**	94.0
Male	early	0.124	1.787	*	**	92.1
	late	0.189	1.167	NS	**	38.0
Fifth	early	-0.064	1.993	NS	**	97.3
	late	0.015	1.896	NS	**	93.4
Fourth	early	-0.040	1.507	NS	**	86.2
	lare	0.014	1.361	NS	**	84.2
Third	early	-0.015	0.729	NS	**	62.8
	late	0.046	0.843	NS	**	50.4
Second	early	-0.019	0.822	NS	**	90.5
	late	0.009	0.822	NS	**	77.3

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)
* = Significant ($P < 0.05$)

Table 8. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Bragg variety. Quincy, Florida, 1977.

	Planting Date	Estimate		$H_0:\beta_i = 0$		N =
		β_0	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	0.059	1.789	**	**	98.6
	late	0.039	1.688	NS	**	95.2
Male	early	0.038	1.783	*	**	98.1
	late	-0.007	1.576	NS	**	86.8
Fifth	early	0.009	1.907	NS	**	96.7
	late	-0.024	1.537	NS	**	89.7
Fourth	early	0.022	1.136	NS	**	81.5
	late	0.027	1.145	NS	**	90.0
Third	early	-0.009	1.042	NS	**	80.5
	late	-0.009	0.770	NS	**	98.1
Second	early	-0.011	0.842	NS	**	88.1
	late	-0.011	0.936	NS	**	94.1
A. hilare						
Female	early	0.132	0.875	**	**	73.0
	late	0.070	1.390	*	**	78.9
Male	early	0.085	1.425	**	**	77.3
	late	0.042	1.618	NS	**	86.2
Fifth	early	0.003	1.176	NS	**	87.0
	late	-0.002	1.722	NS	**	86.7
Fourth	early	0.065	1.617	NS	**	47.4
	late	0.016	1.546	NS	**	91.2
Third	early	0.010	0.767	NS	**	83.6
	late	-0.014	0.744	NS	**	96.2
Second	early	-0.006	0.764	NS	**	87.2
	late	-0.020	0.853	NS	**	95.4
E. servus						
Female	early	0.014	1.947	NS	**	99.3
	late	-0.049	1.950	NS	**	96.4
Male	early	0.004	1.922	NS	**	99.3
	late	-0.021	1.923	NS	**	97.8
Fifth	early	-0.073	2.030	NS	**	98.1
	late	-0.093	2.053	NS	**	98.0
Fourth	early	-0.082	1.607	NS	**	82.6
	late	-0.029	1.798	NS	**	89.4
Third	early	-0.054	1.109	NS	**	43.6
	late	-0.015	0.983	NS	**	76.7
Second	early	0.000	0.680	NS	**	52.3
	late	-0.059	1.367	NS	**	73.6

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)

* = Significant ($P < 0.05$)

Table 9. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Bragg variety. Quincy, Florida, 1978.

	Planting Date	Estimate		$H_0:\beta_i = 0$		N =
		β_0	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	0.197	1.899	**	**	59.3
	late	-0.006	1.795	NS	**	83.4
Male	early	0.249	1.878	**	**	59.3
	late	0.020	1.649	NS	**	85.8
Fifth	early	0.291	1.766	**	**	69.2
	late	0.011	1.705	NS	**	88.7
Fourth	early	0.041	1.385	NS	**	80.5
	late	-0.002	1.560	NS	**	88.6
Third	early	0.204	0.710	*	**	21.4
	late	0.002	0.892	NS	**	89.0
Second	early	0.152	0.866	*	**	50.9
	late	-0.010	0.738	NS	**	72.3
A. hilare						
Female	early	0.206	1.586	**	**	47.7
	late	0.068	1.756	NS	**	76.3
Male	early	0.211	1.385	**	**	43.8
	late	0.047	1.788	NS	**	83.0
Fifth	early	0.236	2.815	**	**	61.7
	late	0.020	1.857	NS	**	87.8
Fourth	early	0.155	2.517	**	**	65.2
	lare	0.011	1.850	NS	**	94.0
Third	early	0.156	0.990	**	**	35.2
	late	-0.006	1.681	NS	**	93.2
Second	early	0.114	0.610	**	**	31.0
	late	-0.011	1.842	NS	**	95.3
E. servus						
Demale	early	-0.053	2.207	NS	**	98.8
	late	-0.082	2.055	NS	**	97.3
Male	early	-0.091	2.251	NS	**	97.5
	late	-0.093	1.881	NS	**	97.4
Fifth	early	-0.615	2.176	NS	**	88.4
	late	0.268	1.540	NS	**	85.7
Fourth	early	-0.342	1.793	NS	**	81.3
	late	0.129	1.131	NS	**	80.5
Third	early	-0.322	1.579	NS	**	61.3
	late	0.014	1.158	NS	**	80.0
Second	early	0.162	0.741	NS	**	48.7
	late	0.207	0.425	NS	**	36.9

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)

* = Significant ($P < 0.05$)

Table 10. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Cobb variety. Quincy, Florida, 1978.

	Planting Date	Estimate		$H_0:\beta_i = 0$		N =
		β_0	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	0.024	2.029	NS	**	93.2
	late	-0.008	1.991	NS	**	96.0
Male	early	0.010	1.934	NS	**	93.0
	late	-0.016	1.988	NS	**	97.6
Fifth	early	0.019	1.437	NS	**	95.6
	late	0.004	2.078	NS	**	99.1
Fourth	early	0.045	1.210	NS	**	79.0
	late	0.006	1.858	NS	**	97.6
Third	early	0.035	0.878	NS	**	74.9
	late	0.018	1.750	NS	**	94.0
Second	early	-0.024	0.705	NS	**	82.6
	late	0.009	1.878	NS	**	90.8
A. hilare						
Female	early	0.100	1.391	**	**	61.1
	late	0.005	1.856	NS	**	96.0
Male	early	0.086	1.340	**	**	76.9
	late	-0.012	2.031	NS	**	97.4
Fifth	early	0.027	1.441	NS	**	68.6
	late	0.004	2.059	NS	**	97.0
Fourth	early	0.001	1.336	NS	**	73.3
	late	0.017	1.721	NS	**	84.4
Third	early	0.004	0.862	NS	**	77.6
	late	0.026	1.621	NS	**	80.1
Second	early	0.003	0.623	NS	**	85.0
	late	0.004	0.805	NS	**	60.8
E. servus						
Female	early	-0.032	1.964	NS	**	98.8
	late	0.025	1.831	NS	**	98.7
Male	early	-0.042	1.885	NS	**	98.9
	late	0.031	1.794	NS	**	98.3
Fifth	early	-0.073	1.592	NS	**	87.7
	late	-0.237	2.029	NS	**	92.8
Fourth	early	0.089	1.307	NS	**	84.0
	late	-0.245	1.638	NS	**	86.4
Third	early	0.002	1.105	NS	**	73.2
	late	0.191	0.791	NS	**	49.1
Second	early	0.018	0.735	NS	**	50.4
	late	0.094	0.499	NS	**	75.5

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)
* = Significant ($P < 0.05$)

Table 11. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Forrest variety. Quincy, Florida, 1979.

	Planting Date	Estimate		$H_o:\beta_i = 0$		N =
		β_o	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	-0.063	1.735	NS	**	87.4
	late	-0.037	1.791	NS	**	93.7
Male	early	-0.003	1.601	NS	**	69.8
	late	-0.033	1.752	NS	**	95.0
Fifth	early	0.134	1.015	NS	**	67.4
	late	0.093	0.637	NS	**	63.2
Fourth	early	0.134	0.651	NS	**	67.4
	late	0.054	0.475	NS	**	66.1
Third	early	0.114	0.237	NS	**	35.0
	late	0.036	0.326	NS	**	42.6
Second	early	0.035	0.259	NS	**	40.6
	late	-0.011	0.456	NS	**	66.8
A. hilare						
Female	early	-0.048	1.400	NS	**	86.5
	late	-0.036	1.838	NS	**	86.7
Male	early	-0.257	1.295	NS	**	87.5
	late	-0.071	1.962	NS	**	89.1
Fifth	early	-0.776	0.690	*	**	73.1
	late	0.043	0.750	NS	**	79.3
Fourth	early	-0.167	0.502	NS	**	69.1
	late	-0.113	0.566	NS	**	65.7
Third	early	0.087	0.414	NS	**	64.1
	late	-0.042	0.325	NS	**	48.1
Second	early	-0.145	0.526	NS	**	65.4
	late	-0.027	0.460	NS	**	66.2
E. servus						
Female	early	-0.048	2.092	NS	**	90.0
	late	-0.036	2.027	NS	**	97.3
Male	early	-0.257	2.374	NS	**	89.3
	late	-0.071	2.120	NS	**	91.5
Fifth	early	-0.776	3.307	NS	**	57.3
	late	0.043	1.735	NS	**	46.0
Fourth	early	-0.167	1.646	NS	**	79.1
	late	-0.113	1.311	NS	**	78.4
Third	early	0.087	0.774	NS	**	80.5
	late	-0.042	0.602	NS	**	89.0
Second	early	-0.145	0.610	NS	**	83.0
	late	-0.027	0.591	NS	**	84.0

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)
* = Significant ($P < 0.05$)

Table 12. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Bragg variety. Quincy, Florida, 1979.

	Planting Date	Estimate		$H_0:\beta_i = 0$		N =
		β_0	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	0.096	1.254	NS	**	74.0
	late	-0.009	1.477	NS	**	94.7
Male	early	0.064	1.487	NS	**	63.1
	late	-0.013	1.496	NS	**	92.9
Fifth	early	-0.062	0.877	NS	**	79.4
	late	0.036	0.851	NS	**	75.2
Fourth	early	-0.023	0.512	NS	**	70.4
	late	0.110	0.534	NS	**	61.5
Third	early	0.070	0.412	NS	**	44.0
	late	-0.117	0.310	NS	**	36.3
Second	early	-0.038	0.449	NS	**	72.2
	late	0.066	0.558	NS	**	45.4
A. hilare						
Female	early	0.151	1.527	*	**	75.0
	late	-0.061	1.649	NS	**	88.3
Male	early	0.188	1.379	**	**	74.7
	late	-0.052	1.686	NS	**	86.8
Fifth	early	0.281	0.765	NS	**	67.3
	late	0.117	0.636	NS	**	67.3
Fourth	early	0.117	0.696	NS	**	72.6
	late	0.107	0.519	*	**	74.6
Third	early	0.103	0.418	NS	**	44.8
	late	0.066	0.435	NS	**	41.4
Second	early	0.144	0.361	ND	**	45.2
	late	0.091	0.520	NS	**	36.6
E. servus						
Female	early	0.821	0.473	NS	**	60.0
	late	0.108	0.396	NS	**	90.1
Male	early	1.136	0.870	NS	**	52.3
	late	-0.062	0.532	NS	**	93.4
Fifth	early	1.917	1.317	NS	**	40.5
	late	-0.263	1.714	NS	**	92.7
Fourth	early	0.270	1.970	NS	**	40.3
	late	-0.191	2.057	NS	**	78.3
Third	early	0.165	1.135	NS	**	32.8
	late	0.468	1.814	NS	**	60.0
Second	early	0.160	1.104	NS	**	30.9
	late	0.180	1.907	NS	**	75.8

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)
* = Significant ($P < 0.05$)

Table 13. Results of regression analyses comparing sweep net and ground cloth for three stinkbug species on Cobb variety. Quincy, Florida, 1979.

	Planting Date	Estimate		$H_0:\beta_i = 0$		N =
		β_0	β_1	i=0	i=1	R^2 (%)
N. viridula						
Female	early	0.136	0.998	NS	**	40.2
	late	-0.029	1.294	NS	**	79.0
Male	early	0.153	1.012	NS	**	34.8
	late	-0.048	1.312	NS	**	80.0
Fifth	early	0.106	0.773	NS	**	52.4
	late	0.071	0.554	NS	**	61.6
Fourth	early	0.059	0.533	NS	**	57.6
	late	0.082	0.476	NS	**	65.0
Third	early	0.068	0.279	NS	**	64.5
	late	0.098	0.445	NS	**	46.5
Second	early	0.019	0.320	NS	**	70.1
	late	0.150	0.479	NS	**	35.3
A. hilare						
Female	early	0.004	1.675	NS	**	71.0
	late	-0.016	1.284	NS	**	69.0
Male	early	0.073	1.288	NS	**	68.0
	late	-0.038	1.305	NS	**	76.2
Fifth	early	0.163	0.691	NS	**	51.7
	late	0.078	0.537	NS	**	64.8
Fourth	early	0.081	0.506	NS	**	52.5
	late	0.141	0.460	*	**	60.0
Third	early	-0.001	0.427	NS	**	80.2
	late	0.169	0.407	*	**	22.5
Second	early	-0.019	0.462	NS	**	81.5
	late	0.165	0.600	NS	*	20.5
E. servus						
Female	early	-0.016	2.146	NS	**	96.4
	late	-0.241	2.338	NS	**	95.3
Male	early	-0.213	2.257	NS	**	97.9
	late	-0.088	2.243	NS	**	97.6
Fifth	early	0.607	2.418	NS	**	85.3
	late	0.749	2.544	NS	**	85.4
Fourth	early	-0.153	2.280	NS	**	73.6
	late	-0.013	2.359	NS	**	75.5
Third	early	0.087	0.862	NS	**	70.0
	late	0.553	0.766	NS	**	57.2
Second	early	-0.126	0.693	NS	**	85.2
	late	0.340	0.498	NS	**	64.1

NS = Nonsignificant ($P > 0.05$)

** = Highly significant ($P < 0.01$)
* = Significant ($P < 0.05$)

Table 14. Regression by field mean of sweep net method on ground cloth method. Quincy, Florida, 1977.

	A. hilare			*E. servus*			*N. viridula*		
	N	β	R^2(%)	N	β	R^2(%)	N	β	R^2(%)
Female	120	1.56 ± 0.052	89.6	120	1.33 ± 0.064	80.7	120	1.90 ± 0.042	95.0
Male	120	1.47 ± 0.062	84.5	120	1.47 ± 0.059	85.5	120	1.76 ± 0.073	84.7
Fifth	120	1.50 ± 0.051	89.2	120	1.37 ± 0.062	82.3	120	2.00 ± 0.033	97.2
Fourth	120	1.10 ± 0.042	86.8	120	1.022± 0.062	72.4	120	1.57 ± 0.064	85.3
Third	120	0.82 ± 0.025	90.9	120	0.74 ± 0.027	87.8	120	0.88 ± 0.069	61.2
Second	120	0.89 ± 0.030	89.4	120	0.76 ± 0.024	90.6	120	1.00 ± 0.066	69.4
Combined	120	1.34 ± 0.039	91.8	120	1.20 ± 0.042	88.7	120	1.82 ± 0.036	96.0

A. hilare + E. servus + N. viridula		
N	β	R^2(%)
120	1.60 ± 0.036	95.1

Table 15. Regression by field mean of sweep net method on ground cloth method. Quincy, Florida, 1978.

	A. hilare			*E. servus*			*N. viridula*		
	N	β	R^2(%)	N	β	R^2(%)	N	β	R^2(%)
Female	120	1.83 ± 0.088	78.4	120	1.58 ± 0.092	71.0	120	1.97 ± 0.026	97.9
Male	120	1.73 ± 0.093	74.6	120	1.60 ± 0.085	74.7	120	1.89 ± 0.027	97.5
Fifth	120	1.66 ± 0.086	75.8	120	1.75 ± 0.129	60.8	120	1.81 ± 0.065	86.8
Fourth	120	1.41 ± 0.058	83.2	120	1.68 ± 0.123	61.0	120	1.45 ± 0.064	81.2
Third	120	0.82 ± 0.087	43.0	120	0.98 ± 0.086	52.2	120	1.09 ± 0.081	60.5
Second	120	0.85 ± 0.073	53.6	120	0.91 ± 0.078	53.5	120	0.53 ± 0.050	48.8
Combined	120	1.69 ± 0.067	84.1	120	1.64 ± 0.100	69.4	120	1.70 ± 0.042	93.0

A. hilare + E. servus + N. viridula		
N	β	R^2(%)
120	1.74 ± 0.042	93.4

Table 16. Regression by field mean of sweep net method on ground cloth method. Quincy, Florida, 1979.

	A. hilare			*E. servus*			*N. viridula*		
	N	β	R^2(%)	N	β	R^2(%)	N	β	R^2(%)
Female	180	1.35 ± 0.064	71.1	180	1.52 ± 0.060	78.0	180	1.85 ± 0.58	85.0
Male	180	1.41 ± 0.077	65.5	180	1.43 ± 0.056	78.2	180	1.92 ± 0.059	85.2
Fifth	180	0.84 ± 0.044	66.3	180	1.67 ± 0.037	64.7	180	2.37 ± 0.112	71.1
Fourth	180	0.53 ± 0.030	63.0	180	0.55 ± 0.030	66.4	180	1.93 ± 0.100	67.6
Third	180	0.30 ± 0.026	42.1	180	0.41 ± 0.029	51.7	180	0.75 ± 0.049	56.4
Second	180	0.31 ± 0.026	44.4	180	0.46 ± 0.031	54.0	180	0.54 ± 0.027	68.0
Combined	180	0.85 ± 0.036	75.0	180	0.81 ± 0.031	79.0	180	1.99 ± 0.069	82.1

A. hilare + E. servus + N. viridula		
N	β	R^2(%)
180	1.69 ± 0.058	83.0

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BIOGRAPHICAL SKETCH

Euripedes B. Menezes was born on August 11, 1942, in Frutal, Minas Gerais, Brazil. He is the first child of two children of Marcelina Gonçalves Menezes and the late Ambrolino Menezes de Souza. Following graduation from Colégio Estadual "Brasilio Machado" (High School) in São Paulo, he attended the Universidade Federal Rural do Rio de Janeiro and received the Bachelor of Science degree with a major in agronomy, in December, 1971. He attended the Escola Superior de Agricultura "Luiz de Queiroz" (USP) and received the degree of Master of Science with a major in entomology in March, 1974. In June, 1974, he became a faculty member at Universidade Federal Rural do Rio de Janeiro, in the Department of Entomology. In June, 1976, he came to the United States and took a course in the English language at Michigan State University, East Lansing, Michigan. In January, 1977, he began the studies for his Ph.D. degree at the University of Florida, Gainesville, Florida.
He is currently a candidate for the degree Doctor of Philosophy in the Department of Entomology and Nematology.

He married Elza Machado Menezes in December, 1971. They have two daughters, Caroline and Jacqueline.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Donald C Herzog

Donald C. Herzog, Chairman
Associate Professor of Entomology

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Dale H Habeck

Dale H. Habeck
Professor of Entomology

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